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From Creativity to Artificial Neural Networks: Problem-Solving Methodologies in Hospitals

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1. Introduction

Health services, viewed systemically, are organizations and complex systems. Their management calls for managerial techniques and instruments that meet expectations raised by professional awareness of complexity and a systemic approach. Systemic approaches are methods for understanding and managing complex health systems in an effective way [1, 2].

The professional nature of health organizations calls for flexible management and continuous adaptation, leading to a real understanding of complexity through a view of organizations as open systems capable of learning within a network of systems [3]. Occupational psychology and company management need to adapt to the world of health systems and hospitals, aware that they are not exhaustive in the analysis or proposition of solutions, because only health service professionals can achieve the perfect synthesis between clinical aspects and organization, ethics and technique that is still so necessary.

The approaches described in the present chapter may be flanked by powerful methods of probability calculation and statistical inference. The aim of the chapter is to provide practical indications and describe the main methods that professionals can apply in the difficult art of health management. The perspective springs from experience in Italian hospitals.

2. Traditional problem-solving techniques

Problem-solving may be defined as an ability that enables any problem to be tackled in any sector, and usually involves systematic changes in point of view. It has various phases:

- Problem finding: realise the discomfort;

- Problem setting: describe, define and frame the question in precise terms, transforming discomfort into a well-defined problem;

- Problem analysis: break the main problem down into secondary problems;

- Problem solving: eliminate the causes and answer the questions raised by the problem;

- Decision making: decide how to act on the basis of the answers obtained;

- Decision taking: act.

Let us look at the definition of problem. A problem is:

- a difficult situation requiring a way out;

- a situation that needs to be tackled by methods that make it possible to avoid obstacles and eventually obtain a result;

- a real-life situation requiring an effective response that is not immediately clear or available;

- a situation requiring some sort of discovery, which may be creative, intuitive, inventive, rational or structural, where attention is directed to procedural activities in order to solve it.

The problem may belong to different categories: concrete, abstract, familiar, unfamiliar, hypothetical or real. We are all accustomed to such situations in daily life, probably without ever realising these details [4].

Problems may be posed by oneself or others; in self-posed problems the solver is the same as the person who posed the problem; in problems posed by others the solver tackles a problem created by third parties. The process of problem-solving is normally systematic, sequential, practical and begins when the problem is realised. Various methods of problem-solving are used in organizations. A well-known approach is summarised in Table 1.

Focus	List problems	Describe problem in writing
	Select problem	
	Verify and define problem	
Analyse	Decide what needs to be known	Reference values
	Gather reference data	List critical factors
	Determine relevant factors	
Solve	Generate alternative solutions	Choice of solution
	Select a solution	Implementation plan
	Develop implementation plan	
Implement	Work for the expected result	Organisational commitment
	Implement plan	Implemented plan
	Monitor impact	Outcome assessment

Table 1. Scheme of a problem-solving process

3. Motivation of personnel

Problem-solving can benefit from motivational analysis of personnel. Motivation can be defined as behaviour that directs energy towards a goal. For hospital problem-solving, motivational analysis can help coordinate efforts. To achieve these aims, occupational activity can be planned in a motivating way. There are various ways of doing this. Organisation and/or general activity should be planned with the following principles in mind:

- *combine tasks* — elementary tasks should be grouped to form a more complex task that can be assigned to a group formed *ad hoc*;

- *organise natural work units* — do not break up activities that have internal completeness;

- *establish relationships with internal and external clients* — this enables workers to perceive the utility of what they are doing and obtain feedback on their performance;

- *attribute personal responsibility* — individuals must feel directly responsible and have a sense of ownership of the results of their work;

- *increase discretionary power* — it is important to give individuals decisional power and control of resources;

- *open various feedback channels* — feedback may be intrinsic to the task or come from others, directly (by face-to-face meetings) or indirectly (by quality reporting).

Other ways of motivating personnel are management by objectives, organisational fairness and participation [5].

Management by Objectives (MB0) implies clear definition of objectives for each organisational member, combined with careful monitoring and systematic assessment, with participation of the employee in each phase of this process. This formula, proposed by Drucker [6], is widely applied and can be linked to compensation over and above fixed retribution by varying pay according to the extent to which objectives are achieved. The following steps, among others, can help to implement this policy properly:

- shared identification of objectives in a meeting of chiefs and collaborators, when how to measure achievement of objectives is also defined;

- specification of expected results in measurable terms, such as "consignment within 24 hours" or "7.5% annual increase in sales";

- assignment of temporal goals for achieving an objective;

- monitoring at regular intervals (e.g. monthly), followed by feedback enabling individuals to modify their manner of working.

Significantly, there are two main classes of objectives: contribution and competence objectives. The former are related to collaborator performance and may regard the results (e.g. 5% reduction in rejects or waste) or quality (e.g. 10% increase in customer satisfaction). The latter regard acquisition of knowledge and skills necessary for reaching contribution objec-

tives. These skills are part of the model defined by the organisation (e.g. attention to clients, team work, innovation, time management) but not all of them are equally important for a given worker. In brief, growth objectives must not be fixed for all skills, but only for those truly significant for an individual at a given time, in relation to task.

The theory of Adams [7] favoured development of a line of research and intervention regarding organisational fairness. It aimed to promote perception of equity in the workplace, where on-site studies suggest that sense of fairness may have three main components:

a. *distributive fairness,* regarding the equity with which rewards (e.g. economic incentives or promotion) are assigned; what individuals see as the relationship between rewards and performance (result, commitment, skills, etc.);

b. *procedural fairness,* regarding the process by which such rewards are assigned; in this case what individuals see not as the result of distribution but the *rules* used for distribution (e.g. their coherence in time and between individuals, the quality of the information available on which to base evaluation, the absence of voluntary or involuntary errors by decision-makers, etc.);

c. *fairness of interactions,* regarding the quality of the relationship between management and collaborators; what the parties view as reflecting honesty, respect, courtesy, empathy, etc.

The meta-analyses of Cohen-Charash & Spector [8] and Colquitt et al. [9] show that working performance is positively associated with distributive and procedural fairness, but the latter enables better prediction of results. Moreover, the three forms of fairness are correlated positively with motivation and negatively with intention to leave the organisation and with employee turn-over.

The perception of procedural fairness is positively influenced by the possibility of taking part in the assessment process [10]. Distributive and procedural fairness are also promoted by allowing employees to appeal against decisions that regard them [11]. The above studies show that a further motivational lever concerns participation. Fifty years ago, McGregor [12] invited a whole generation of managers and organisers to revise their concept of individuals at work and change from an authoritarian to a participatory style of management. He sustained that humans are not to be considered intrinsically lazy and needful of direction and control, but that they seek growth and responsibility and are willing to work for organisational goals. Since McGregor, the concept of participation has developed and is currently considered an indispensable support for motivation. In concrete terms, there are different areas of activity in which it is possible to increase participation:

- transformation of general into specific objectives;

- decision-making;

- identification, analysis and solving of problems;

- definition of values and policies;

- implementation and monitoring of changes;

- control of resources (instruments, budget, consultants).

Among the advantages of a participatory management style, scientific studies showed improvement in performance and productivity, better quality and attention to clients, creation of a cooperative atmosphere and a consequent reduction in internal competition and more probability of emergence of hidden talents [13].

4. Information management

Since management of a system assumes knowledge of that system, the solution of hospital problems requires detailed knowledge of hospitals. This not only concerns structural and functional knowledge that can be obtained from official data, but also knowledge of the dynamics of internal relationships, for which it is necessary to use interviews or the technique of systematic communication. Internal dynamics elude standardized modes of acquiring information, being a partly individual, partly shared form of knowledge belonging to the emotional constitution of healthcare personnel. Since internal dynamics have to do with the deepest part of personnel motivation, they normally elude conventional interviews, which are limited to communicating ways of working or technical approaches to healthcare, and call for induced communication techniques. The manager detects uncertainty, nervousness or outright difficulty in the person being interviewed. He uses these emotions to induce the person to communicate things that are difficult to admit. These situations of emotional difficulty are found in all hospital units, even the best ones, and represent a failure of one or more staff members that the person in charge usually has difficulty in admitting. Knowledge of situations of emotional difficulty allows the manager to intervene in internal dynamics, reassuring where the dynamics generate anxiety, and intervening drastically where there is danger of uncontrolled situations with risks for patients.

The interview technique is the most common and is generally used for the heads of units or directors. The technique of systematic communication, on the other hand, is used for all personnel, without distinction of rank. It is normally more laborious and expensive, but may provide indirect information or feedback and a key to ward dynamics.

Induction of communication is a delicate art, calling for tact, astuteness and discretion on the part of the manager. The person being interviewed must have complete trust in the confidentiality of the communication and must perceive that sincerity will be rewarded through a preferential relationship with top management, even if a degree of weakness is revealed. A lever often used in induction of communication is narcissism. Many heads aspire to respect in the hospital environment and are willing to give up something to obtain consensus or an apparently dominant position over other colleagues.

Another technique of hospital management is based on acquiring unconventional information. The manager acquires information, not directly linked to hospital activity, from sources outside the hospital. This information may, for example, regard external professional activity, activities unrelated to healthcare, political orientation or the private sphere of the health-

care worker. Although unbecoming and often a source of gossip, the working environment produces much information of this type, which may come to the attention of managers without their solicitation.

A considerable source of information on hospitals comes from the press, which may amplify information not obtained through the normal channels of communication but from health personnel, despite existing prohibitions. Cases of malpractice are a typical example, but the press may also pick up news from staff wishing to air situations of internal uneasiness. Such cases of instrumental use cannot be disciplined, however they increase knowledge of internal dynamics.

These are ways in which managers pursue the aim of information asymmetry to gain advantage with respect to directors, who come to be in a position of psychological inferiority. The manager who "knows more" plays his information more astutely, only showing his "aces" when necessary and waiting for his adversary to make a mistake. These are questions of power, as management of information is in many cases closely linked to the management of power.

In conclusion, in the framework of hospital problem-solving, managers make wise use of the conventional and non conventional information they obtain, increasing information asymmetry in order to direct personnel behaviour towards better organisational performance.

5. Operative management techniques

The solution of certain hospital management problems can be attempted by five basic methods:

1. framing of responsibilities;

2. raising the level of conflict resolution;

3. delay techniques;

4. responsibility shift;

5. management through competition.

The first is a consolidated management technique regarding the definition of *who does what*. Framing of responsibilities is actually defined by the statute of the hospital in organisation and function charts. Using these charts, certain problems can be solved simply by correct distribution of responsibilities between directors (Figure 1).

The second method consists in realising that conflict exists between employees belonging to non-decisive levels of management (e.g. between nurses and auxiliaries) and in investing the next levels up with the question (in the example, the ward sister, clinic director and director of health professions). If this does not work, higher levels are invested with responsibility. Raising the level of conflict resolution normally puts an end to the conflict by easing emotivity and direct interest.
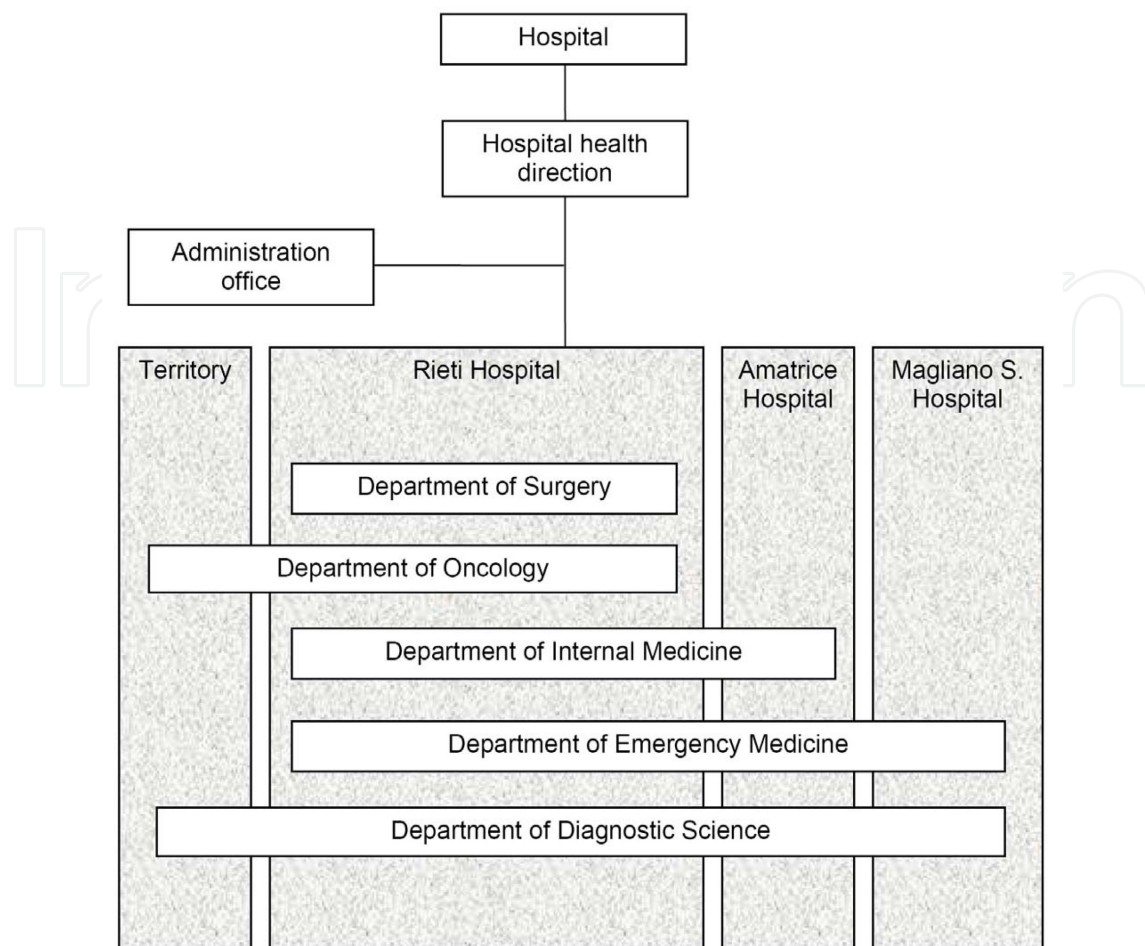
Figure 1. Function chart of Departments of Rieti-Amatrice Hospital – Italy (by kind permission of ASL Rieti).

The third method is applied when a request is patently out of proportion with the material resources or time available to provide an adequate response. Delay techniques may consist in requiring complicated forms to be filled in, asking for a detailed report or phone contact with an office known to be poorly staffed or slow to act, and so forth. The bureaucratic elephant will ensure that the request disappears into the administrative machinery.

The fourth method exploits the uncertainty or complexity of certain organisational arrangements and consists in referring the question to a third office for an opinion, verification, technical advice or further laboratory control to transfer the applicant's attention from the core problem to an unlikely external authority. Third parties are involved by sending them copies, in which something is requested of them, knowing that only a meticulous reader will discern the deception.

The fifth method (management by competition) is based on the principle of narcissism. When a problem is not tackled by a healthcare worker, it is suggested that the sector be handed over to another whose skill is well known and who would be happy to take over. Usually narcissism comes to the rescue, making the director change his mind and become more amenable to compromise.

6. Creative or heuristic methods

An innovative method of problem-solving known as "creative" was recently proposed. Its features include learning different ways of creative thinking, eliminating preformed schemes and stereotypes and taking a richer approach to problems. Creative problem-solving is particularly useful in project design phase, when the objective is to correctly identify problems and solutions using instruments that reinforce creativity by encouraging original and innovative ideas. The concept of creativity was defined appropriately by Poincaré when he stated that creativity is joining existing elements by useful new connections and that invention consists not in building useless combinations but only useful ones, which are a tiny minority. The conclusion is that a new result has value, if any, when by establishing a link between known elements, hitherto scattered and apparently unrelated, it immediately creates order where disorder seemed to reign.

This type of approach exploits heuristic methods without a mathematical foundation. The solution is identified iteratively, seeking to optimise one or more objective functions within an allowed region. Ideas are typically generated by brainstorming. The aim is to focus on the problem and then let various original solutions emerge deliberately, without any preconceived order. Discussion and exchange of opinions enable an iterative approach that leads to a solution regarded as optimal.

The processes of the creative method are:

• establish priorities;

• seek alternatives;

• formulate hypotheses;

• generate new ideas.

Creative methods can exploit mind mapping, a powerful technique of graphic representation of knowledge that provides a universal key to the potential of the mind. A mind map is a diagram in which concepts are presented in graphic form: the main idea is in the centre and more detailed information is added piece by piece (Figure 2). Mind maps express radiating thoughts and are therefore a natural function of the human mind [14].

Mind mapping is based on the results of research into:

• the possibility of the human mind to associate concepts and information in a non linear manner;

• the functional differentiation of the two lobes of the brain:

– the left lobe processes information in a linear, logical, analytical, quantitative, rational and verbal way and is stimulated by written and verbal representations;

– the right lobe works in a non linear, holistic, intuitive, imaginary and non verbal way and is stimulated by hierarchical, spatial, symbolic and coloured representations.

Research has led to the identification of a method that enables information and ideas to be represented through logical-rational and imaginary-creative functions. Mind maps differ from other methods of representation of knowledge because they emphasise:

- the hierarchical-associative structure of information;

- the use of elements of high perceptive impact, such as colours and images, that stimulate the creativity of the producer and capture the attention of readers.
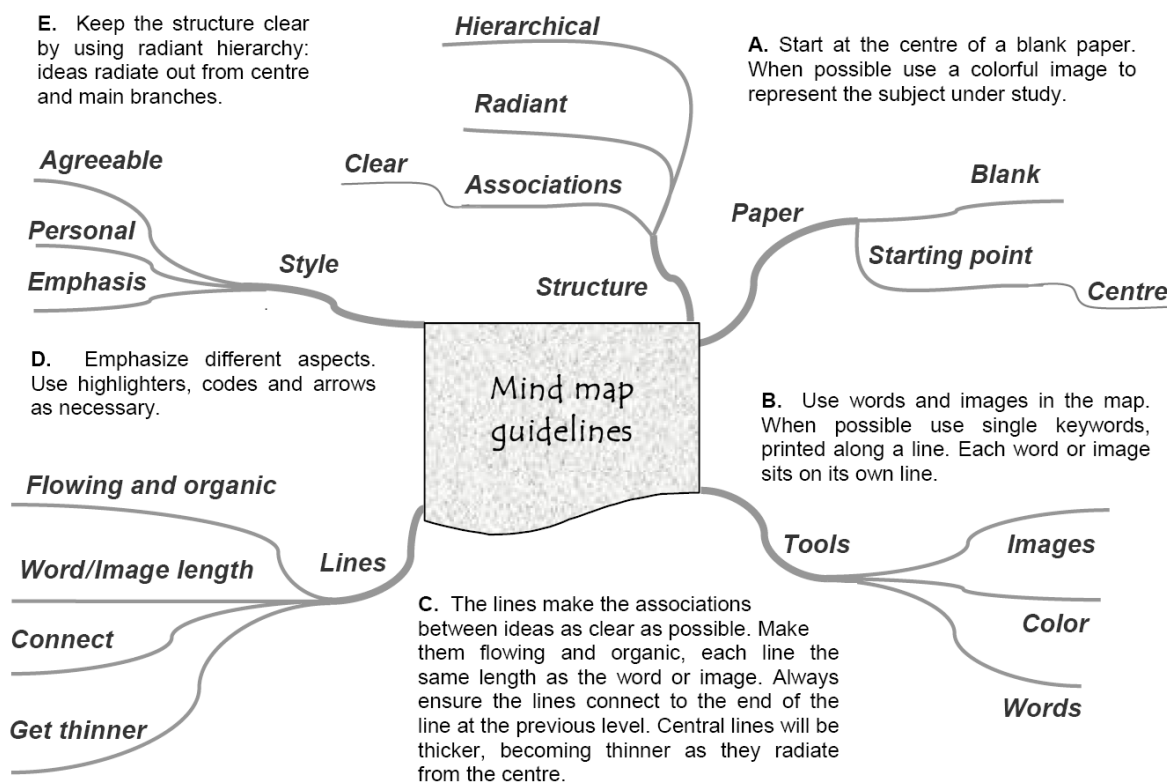
E. Keep the structure clear by using radiant hierarchy: ideas radiate out from centre and main branches.

Hierarchical

Radiant

A. Start at the centre of a blank paper. When possible use a colorful image to represent the subject under study.

Agreeable

Clear

Personal

Associations

Blank

Paper

Style

Starting point

Emphasis

Structure

Centre

D. Emphasize different aspects. Use highlighters, codes and arrows as necessary.

Mind map guidelines

B. Use words and images in the map. When possible use single keywords, printed along a line. Each word or image sits on its own line.

Flowing and organic

Word/Image length

Lines

Tools

Images

Connect

C. The lines make the associations between ideas as clear as possible. Make them flowing and organic, each line the same length as the word or image. Always ensure the lines connect to the end of the line at the previous level. Central lines will be thicker, becoming thinner as they radiate from the centre.

Color

Get thinner

Words

Figure 2. Mind map guidelines.

The paradigm of linear representation envisages a static beginning and end to a logical process, preventing the effective creation of associations, whereas mind maps offer a dynamic approach and envisage a centre but not an end. A graphic representation with these characteristics is very effective:

- as a support for creativity because it stimulates ideas and associations not yet elaborated (in a mind map, every branch can in turn be the centre of another more detailed mind map);

- as a support for representation, because it enables an overall vision, helping work on existing thoughts and ideas as well as on everything still to be developed from them;

- in the communication of thoughts, because it makes conceptual links graphically explicit and facilitates creation of mental associations.

For example, mind maps can be used:

- in the personal sphere to elicit ideas and then to fix and elaborate them;

- in group work to represent the information and ideas of different people on the same map, facilitating exchange and accelerating the transition from elaboration to performance;

- in the management of distributed knowledge to represent information using standards and representational devices that favour an objectivised interpretation and view.

General fields in which maps can be applied include:

- creativity: to generate ideas autonomously or in groups by brainstorming;

- analysis: to represent, evaluate and compare various options in the act of problem-solving and decision-making;

- communication: to convey information in a simple intuitive manner, emphasising logical links and facilitating dialectic and exchange;

- organisation: to structure activities, allocate resources, assign times and gather necessary information;

- documentation: to lay out documents and plan document structure.

7. Pragmatic methods

A typical example of the pragmatic approach is lean thinking. The aim is to make a little go a long way by reducing waste. The problems are studied in action and the solutions must be simple. The term *lean* indicates a process close to maximum efficiency, a process of optimisation with continuous endeavour to reduce waste and unproductive activity. The word was first used in this sense in the 1990s, but the concept is exemplified by the Toyota production system invented by Taiichi Ohno after World War II. The lean approach consists in analysing processes, mapping activities connected with processes, and identifying productive activities and their flows. Activities that add value are distinguished from those that cause a loss of value.

Application of this approach in the health services is not completely intuitive. The parallel with industry may seem bold, but the activity of a health unit is actually based on processes and pathways often similar to those of industrial production. Applied to health systems in the last 7-8 years, the model is based on recognition of the fact that all activities form production lines [15]. Activities have an ideal pathway that is rarely recognised and followed. The aim is to try to achieve an optimal pace without unnecessary interruptions and unex-

pected obstacles. All components of a given line of activity are brought together to decide the best pathway with the best timing and the appropriate resources. For example:

- several meetings are held to involve everyone. The components, unaccustomed to sharing their small and big problems, produce a quantity of problems, mainly organisational, that are ordered by priority and solved (capacity for teamwork is necessary);

- the organisational methods sustaining this principle include value stream maps and rapid improvement events that can be applied in specific areas known as production cells.

The techniques, clearly described and easy to learn, must be agreed on and adopted by operative personnel, becoming part of a mechanism of change (improvement) by progressive involvement plans. The aim for all is to reduce space, distance, effort, stocks and service time.
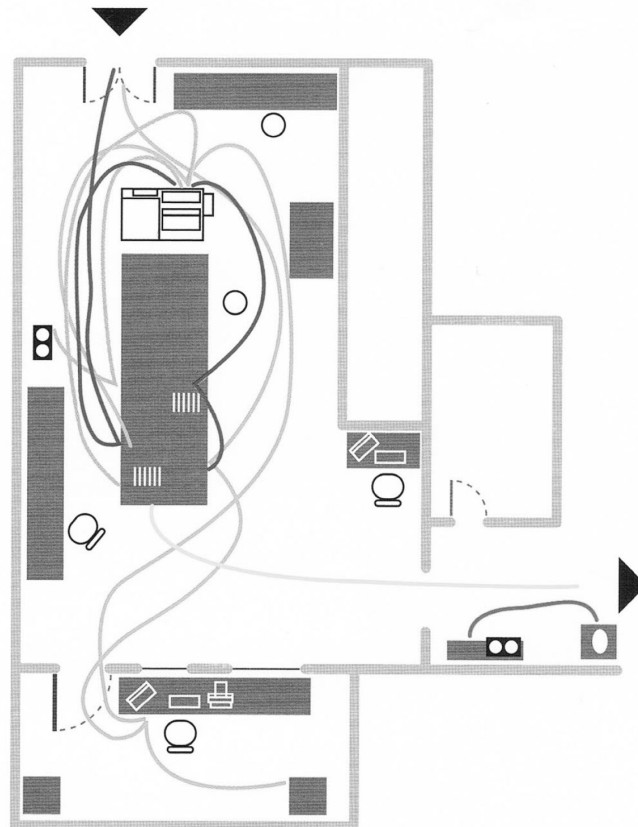

Figure 3. Example of spaghetti chart.

A graphic tool that can help in applying lean thinking is the spaghetti chart, which represents the movements of an element (patient, personnel, biological samples, etc.) in the value stream of the organisation. The tangled form of the chart may resemble a plate of spaghetti. Spaghetti charts can be used to analyse all the movements of personnel, biological samples,

patients or anything else that is moved in a specific area (Figure 3). Goals take time and must be planned by the general management, without the support of which only minor progress is possible. However, once underway, the immediate results are incredible. Supply improves in the points where maps were used. The improvement becomes visible and elicits amazement that the solution was never thought of before. The challenge is met by those understanding the concept of flow and the need to maintain the wave of action. The need for territorial assistance pathways from the hospital is another necessary but not sufficient tool. Without the concept of flow, value to improve and waste to reduce, continually and obsessively, little progress is made. If a scheme is applied but not carried through, the mechanism stops. On the other hand, if it is fuelled by realisation of the true requisites, the hospital pulses with the synchronous activities of planned flows. This is possible because besides the concept of flow, not as influx of clients in part of the organisation (clinics, emergency, outpatients, operating theatres, with problems of variations in demand) but as flexible supply of services, it is fundamental to recognise the concept of waste in internal activities, estimated to be around 80-90% in current hospital activity lines [16]. The actions performed in activity lines can be improved in terms of organisation, logistics and efficiency. The concept of speed and volume of activity is not what counts, but rather the right flexibility for the volume of activity necessary and useful for patients.

8. Mathematical methods

Mathematical methods can be applied to problem-solving in two main ways: Bayesian networks and artificial neural networks, that can also be used as complementary tools.

8.1. Bayesian networks

A Bayesian network (also called belief network) is a probabilistic graphical model able to represent the dependence between random variables and to give a concise specification of the joint probability distribution [17]. This type of model is a powerful tool which can be particularly suited to describe dependencies among variables and to support the decision-making process in situations of uncertainty [18].

For explanatory purposes, an illustrative example of a simple Bayesian network model is shown in Figure 4. The network is composed of five nodes and four arrows. Each node represents a random variable (work, environment, age, disease and symptoms) and arrows represent conditional dependencies between variables. The figure points out that a disease is dependent on age, work and environment and that symptoms are dependent on the disease. According to this model, the probability of a disease is conditioned on three variables (age, work and environment), while that of symptoms depends only on the disease. $P(W)$, $P(E)$ and $P(A)$ represent the absolute probabilities of work, environment and age, respectively. $P(D|W,E,A)$ is the conditional probability of disease and $P(S|D)$ is the conditional probability of symptoms.

In summary, the example shows that a Bayesian network is a graph in which the following holds:

1. A set of random variables makes up the nodes of the network.

2. A set of directed links or arrows connects pairs of nodes. The intuitive meaning of an arrow from node X to node Y is that X has a direct influence on Y (X is called a parent of Y, and Y is a child of X). The lack of an arrow between two nodes indicates their conditional independence.

3. Each node has a conditional probability table that quantifies the effects that the parents have on the node. The parents of a node are all those nodes that have arrows pointing to it.

4. The graph has no directed cycles (hence is a directed, acyclic graph, or DAG).
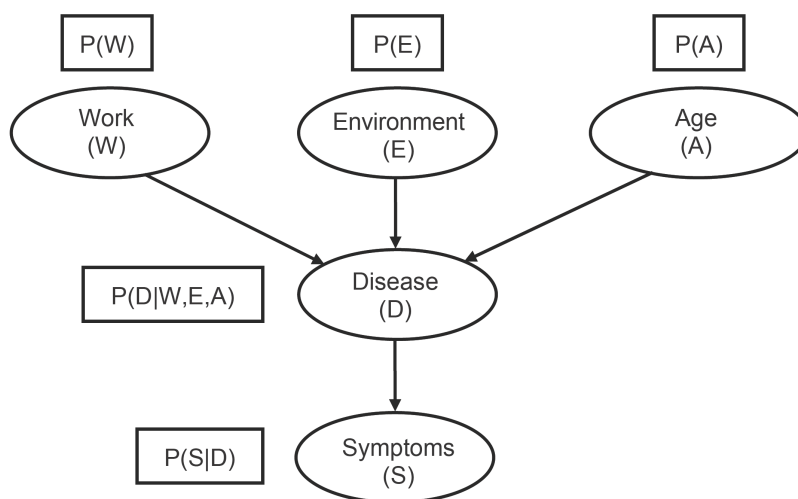

Figure 4. Illustrative example of Bayesian network. P(W), P(E) and P(A) represent the absolute probabilities of work, environment and age, respectively. P(D|W,E,A) is the conditional probability of disease and P(S|D) is the conditional probability of symptoms.

Learning the topology of a Bayesian network from data can be a difficult problem, as its associated search space is super-exponentially large. However, in a lot of cases, it can be easy for a domain expert to decide what direct conditional dependence relationships hold in the domain - much easier, in fact, than actually specifying the probabilities themselves. Once the topology of the belief network is specified, we need only specify conditional probabilities for the nodes that participate in direct dependencies, and use those to compute any other probability values.

Manual construction of a network involves various development stages. For each of these stages, knowledge is acquired from experts in the domain of application, the relevant medical literature is studied, and available patient data are analysed. As developing a Bayesian network is a creative process, the various stages are iterated in a cyclic fashion where each stage may, on each iteration, induce further refinement of the network under construction.

Bayesian networks can be used for data classification, identification of causal relationships and output prediction. They allow a domain expert to model uncertain relationships between a variable of interest with unknown values and clinical findings/observations (known variables) and are particularly useful for medical diagnosis [19-21]. Attractive features of Bayesian networks include encoding dependencies among all variables, thereby addressing problems with incomplete data; informing causal relationships, thereby increasing understanding about a problem domain and predicting consequences of treatment; combining prior knowledge (which often comes in causal form) and available data; and user friendliness of graphical representations.

From the above we can realize that Bayesian networks seem to be suitable tools in hospital context, because they are intuitive, even to the novice, and allow for incorporating qualitative knowledge and statistical information which is often easily available in medicine. Moreover, they can be used not only for clinical purposes, but for many other problems associated with the management of health, e.g. for health economic evaluations [22-23].

A special case of Bayesian network is the well-known naïve Bayes classifier. It is an ancient form of Bayesian network that continues to have particular success in various fields of application by virtue of its simplicity and good performance. Naïve Bayes models are often used in medicine for pattern recognition and to aid clinical decisions [24].

A more detailed discussion on Bayesian networks is available in the present book in the chapter entitled "Bayesian Approach in Medicine and Health Management".

8.2. Neural networks

Artificial neural networks (ANN) are powerful tools that can be used to manage knowledge and solve problems [25]. They are information processing systems that reproduce by computer the function of a very simplified biological neural network, composed of a certain number of interconnected neurons. Intelligent behaviour springs from appropriate interactions between interconnected units. Figure 5 shows an example of stratified feed-forward ANN architecture.
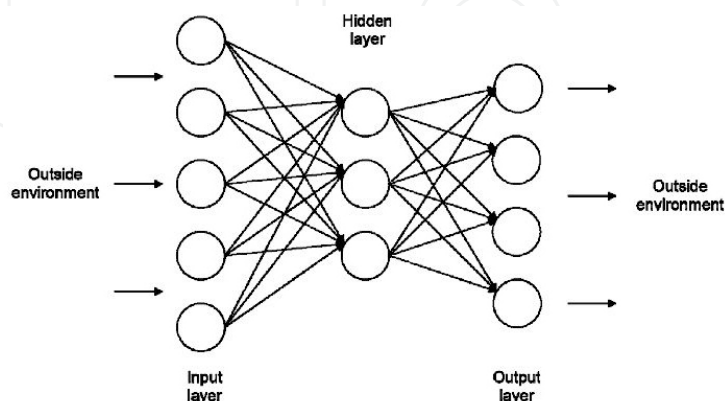

Figure 5. Example of stratified feed-forward artificial neural network architecture. The ANN architecture consists of three layers of neurons. The neurons in a layer only project onto those in the subsequent layer.

The architecture of the artificial neural network shown in Figure 5 is said to be stratified because it consists of a number of layers of neurons. It is feed-forward because the connections only project forward, that is, the flow of information moves in one direction from input to output. The neurons in a layer only project onto those in the subsequent layer. There are no connections between neurons in the same layer or between non-adjacent layers.

In a stratified feed-forward network all connections between neurons can be described quantitatively using a number of tables (matrices) equal to the number of pairs of adjacent layers. The ordered elements of each matrix represent the weights of the connections between corresponding pairs of neurons in adjacent layers.

To design an artificial neural network it is first of all necessary to carefully identify the inputs and outputs to the system in order to define the context correctly and completely. Not much can be said about the topology of the network to use, because there are no theoretical criteria that enable the ideal type of network (feed-forward or feed-back) or the optimal number of layers, neurons and connections to be identified a priori. In general, ANN topology is chosen empirically in relation to the problem to solve.

Perhaps the greatest difficulty in using ANNs for problem-solving is the difference between this type of approach and a conventional algorithmic approach. Conventional approaches use a specific algorithm and the computer is programmed to follow a set of instructions that reflect the algorithm that will solve the problem. On the other hand, ANNs use a pattern-recognition approach to the problem, exploiting the information contained in available data (data driven) rather than an algorithmic perspective. In other words, once ANN structure has been chosen, the network is trained to solve a problem using a training set of examples. Examples must be chosen with care so as not to waste time or train the network in the wrong way. Thus the performance of ANNs depend greatly on the training set: the more the set represents the problem and is complete, the better its performance and capacity to provide appropriate responses to inputs not analysed during training (generalisation power).

The ANN and conventional algorithmic approaches are not actually contradictory but complementary. In some situations one or the other is preferable, in others the two can be combined. Although ANNs have proven successful, they are not suitable for all types of problem. Current consensus on ANNs is that they do not work miracles, but if used intelligently can give surprising results. They undoubtedly have certain strengths with respect to the human brain, such as good performance even in situations where human judgment may be penalised by fatigue, lack of motivation and poor memory. A certain weak point lies in the fact that human decisions are often based on perceptions and are modified in the course of time by life's experiences that mature the person and cannot be reproduced by artificial learning.

A conclusive consideration is possible comparing Figures 4 and 5. Similarities can be observed between the structures of Bayesian networks and artificial neural networks. Despite these analogies and often similar performance, it should be borne in mind that the parameters for designing Bayesian networks are conditional probability relationships between two

random variables, characteristic of the problem (network nodes), whereas those of ANNs do not have this meaning.

9. Conclusions

Hospital problem-solving is the daily bread of hospital managers and doctors with managerial roles, especially those in hospital medical management, who are the main specialists in this subject. Irrespective of clinical provenance, doctors involved in medical management acquire experience in problem-solving, usually self-taught since the subject is often neglected in specialisation schools.

As we have seen, problem-solving calls for a scientific multidisciplinary approach with psychological adaptation of method to context. The ability to interpret the system as a whole and to knowledgeably mix various management techniques are not for everyone and even the best versed colleagues need time and practice.

The author hopes that this chapter will promote reflection on the topic, suggesting fields to investigate in more detail and eliciting recognition by doctors working in hospital organisation.

Acknowledgment

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