Chapter 4: The History of Medicine in Four Acts

If we take the Hippocratic texts of the fifth century BC as the starting point, as is widely accepted, medicine has a history of more than 2,500 years. However, with the registers of attention to diseases and curative acts described in ancient Egypt, China, India and Mesopotamia added, medicine is perhaps more than twice as old.

The consensus on the Hippocratic texts as the birth of Western medicine is justified due to the originality of the deployment of principles of systematic observations and rational considerations about the human body and its diseases, without resorting to Gods, magical influences or flimsy causality assumptions. The medicine invented in the fifth century BC is therefore scientific medicine, as we still understand it today: empirically based and rational.

The 2,500 years of history is rich in breakthroughs and remarkable advances, replacing improvements of previous periods but also continuously selecting and preserving accepted knowledge and practices as deemed appropriate.

There are many ways of telling the history of medicine or dividing it into periods. The history we are about to tell is divided into four periods: the first from the fifth century BC to the fifth century AD; the second from the sixth to the fifteenth centuries; the third from the sixteenth to eighteenth centuries; and the fourth from the nineteenth to twenty-first centuries. The reason for these divisions is our perspective of analysis; these periods offer clear distinctions when linked to the evolution of societal structures as proposed by the Social Systems Theory.

The first two periods happened within societies with *stratified differentiation*, firstly, in ancient Greek and subsequently Roman societies (first period), and secondly in the Middle Ages. The two periods unfold from the pinnacle of Greek civilization to the fall of the Roman Empire, and after that under the domain of the Catholic Church. Although within the same form of social differentiation, these two periods present important differences on how medicine was viewed and practised.

The third period is the transition from stratified to functional differentiation. In this period it is possible to see medicine acquiring features that would subsequently lead to the establishment of health systems as fully differentiated function system, in societies where several function systems coexist in each other's environment.

For each period we describe the central themes of medical self-reference, giving summary descriptions of what those themes entailed. More specifically, for each of the four periods we give: (1) a brief characterization; (2) the system's features, in line with the Social Systems Theory; (3) a discussion on its complexities; and (4) a summary of medicine self-reference of the period.

As usually told in textbooks, the history of medicine is the narrative of scientific progress in the medical field. The relevant events and players are the breakthroughs and the scientists who made them. Many but not all were doctors, but their discoveries had far-reaching consequences on the practice of medicine as social function and professional field dedicated to the treatment of disease and the preservation of health.

In Chapter 1 we addressed briefly the difference between the function system of science and the function system of health. These systems started to be constituted as social function systems around the seventeenth and eighteenth centuries, a period when societies were not yet structured according to the function differentiation that would fully emerge in the early nineteenth century.

The separation between practitioners and scientist doctors was never fully marked before the sixteenth and seventeenth centuries. The science and practice of medicine were undistinguishable until then, although only those who had scientific orientation towards the sys-

tematization of new knowledge became recognized in the history of medicine.

The two realms, science and medical practices, overlapped and showed couplings; and they still do, as when, for instance, experimental treatments are performed in controlled trials, and when practitioners make daily records of their patients as data for health surveys or epidemiological studies.

As mentioned in the previous chapter, the differences are nevertheless clear, when on one side the doctors deploy the knowledge already established, with the means available to them at the point of care, and on the other side the doctors/scientists try to expand the overall knowledge of specific diseases or bodies' functions. The time horizons and intended effects are different, one being of immediate consequences for an actual patient, and the other in principle aiming to benefit the whole human species.

Although the history of medicine is the narrative of sequences of scientific progress, the actual history of medicine is also the history of service provision and part of the history of the evolution of health systems, from embryonic stage to full development. The history of medicine is also the evolution of the self-reference of medicine, leading eventually to the self-reference of medicine within the self-reference of health systems.

First period (from the fifth century BC to the fifth century AD). Craftsmen's medicine, observing the surface of the body at the bedside

Characteristics of the period

The period from the fifth century BC to the end of the Roman Empire (fifth century AD) starts with the Greek texts attributed to Hippocrates from Kos and anonymous authors whose works comprise the Hippocratic Corpus collection. The texts strongly influenced the practice of

medicine in Persia and Alexandria and later in the Arabic-dominated regions, as they were translated into those respective languages.

Among the ancient societies that developed the capacity to write complex observations and thoughts, the Greek civilization showed remarkable achievements in many areas.[1] This is also where the interest in making systematic records of observations made at the bedside of those suffering from illness first appeared. It is therefore called the birthplace of medicine as we know it: a rational practice based on observed evidence seen in the human body.

It all started, then, with the collection of countless written records of patients being observed and treated by those doctors. Hippocrates formulated the style of attention and objective recording of observations, setting in motion a definitive innovation from previous healing practices. No longer seeking explanations in or summoning help from supernatural forces, the declared Hippocratic intention was a bet on the future, hopeful of better understanding of what was being precisely recorded.

In his outstanding scholarly study of the progress of Greek medicine (on which most of our comments in this section is based), *The Invention of Medicine, from Homer to Hippocrates*, Robin Lane Fox (2020) focuses on Books 1 and 3 of the Epidemics volumes in the Hippocratic Corpus, which he sees as following the same style, suggesting they were written by the same author, possibly Hippocrates himself. The Corpus is a collection of about 60 books, written over a period spanning perhaps 10 decades, from the mid-fifth century BC to the mid-fourth century BC, admittedly written by several authors with different styles.

About those two books, Fox observes the consistency of the simple and objective language. The texts acknowledge that causes and treatments of diseases were not yet known and all that could be effectively

1 We make a small digression to suggest that perhaps linguists may have an explanation, linking the versatility of written Greek and its potential to create textual forms translating complex observations as well as abstract ideas, something that, perhaps, the hieroglyphic pictographic representations would not permit. This is just a hypothesis, to be discussed or dismissed.

done was the written record of everything that seemed to be relevant from what was observed on the surface of the bodies of patients. The observations could not go deeper because the knowledge of human organs and physiology was poor – and basically wrong. Furthermore, dissections of human bodies were forbidden and the only knowledge of anatomy available was acquired from observation of animals or soldiers wounded in combat (as described in Homer's poems before Hippocrates).

Nevertheless, Fox presents translations of cases and we can appreciate the concision and objectivity of the records. Based on those simple, superficial descriptions of signs and symptoms, some cases can be tentatively classified with the current nosology.

The texts became fundamental for those interested in the practice of healing. Printing did not exist and books were written by hand. They were very expensive and hard to find. Teaching activities were organized around individuals recognized as knowledgeable doctors, who would have copies of the texts in which students could read descriptions of the progression of signs and symptoms. Medical training was mainly available to those who could afford to pay the master. Because literacy was not widespread, access to the medical texts was in fact the privilege of a small minority who therefore kept the knowledge within well-off families and groups. As in any other craft, medicine required a long apprenticeship.

Historically, once Roman hegemony was established, Greek medicine migrated to Rome, which did not have a developed medicine of its own. Rome and Alexandria in Egypt became the centres of medical knowledge of the Western world. The pattern of direct observation for prognosis initiated by the Greeks was thus preserved.

As valued practices performed by craftsmen trained by other craftsmen, medicine was an individual business service, mostly sold to those who could afford it. Anything similar to organizations with the exclusive purpose of providing healthcare would consist of no more than a small group of doctors, often from the same family, working together.

Medicine was practised at the bedside in patients' home, although some doctors had their own facilities. That period also saw the estab-

lishment of what could be called rudimentary "hospitals", set up for the treatment of wounded soldiers, and in some cases for containment of diseases considered dangerous ("leprosy" for instance), those infected were kept confined but without treatment.

As already noted, dissection was forbidden and the understanding of anatomy was extremely basic and often wrong, based on observations of the surface of the body. In second-century Rome, Galen (who upheld most of Hippocrates' teachings, approaches and principles) added anatomical features not seen in the Greek texts, with a remarkable although still rudimentary understanding of the circulatory system. However, his works contained many misrepresentations and gaps, such as the absence of reference to the nervous system.

The survival of the distinctive Hippocratic approach of systematic direct observation and descriptive writing of the sequences of events, day after day, to the end of the case (mostly with death), and the limited ambition and scope of the interventions, is indeed remarkable, considering the social context where religion was a strong presence in the daily life. Charlatanism was widely accepted and practised with mixed prayers, religious beliefs and alleged healing practices, with no regard to the written texts. The mixing of religious beliefs and healing practices undifferentiated the medical craft, therefore delaying the closure of systemic self-reference (more on this later).

Medicine self-reference was almost non-existent, in the sense of regulations and supervision of practices. Anyone could do anything. Knowledge was not controlled and organizations did not try to assure consistency across practices and reliability of those calling themselves doctors. The acquisition of "respected doctor" reputation was a process to which the existence of powerful patrons (such as kings and nobles) and the recognition of a certain posture in relation to patients and diseases were fundamental.

Nevertheless, to become a doctor in the tradition established by Hippocrates, the aspirant would be orientated to voluntary adoption of the Hippocratic Oath and observation of Hippocrates' Aphorisms. In a context without regulatory authority controlling or overseeing practices, practitioners were left with individual or small group self-

observation of the principles of the craft; "Do no harm" was one of the most famous. But charlatans could also pretend to follow the oath.

There are references to "schools of medicine" in some books on the history of medicine. For instance, there are references to the "empirical school" and the "dogmatic school" and also to the "methodic school". We may interpret that as a way of explaining in simple terms the separation of different orientations. However it is widely accepted that the term school by no means resembles the current use of the term. Any differentiation between schools would be precarious and with little basis in distinct observations of the body or distinct therapeutic methods, never mind regulations. The therapies available were basically the same and the explanations about the cases were strongly dominated by simple frameworks such as the four humours

Indeed there are records of authors from the same period who drafted different notions, such as Alcmaeon of Croton (fifth century BC), considered the first philosopher of medicine (who carried out animal dissection and possibly, it is speculated, of humans too), and emphasized the importance of the solid parts of the body, not only the fluid humours. However, even with the formulation of distinct frameworks (like those related to seasons, or atoms, or "critical days" in the prognosis of the disease), these views would share the same ignorance of the complexity of the body and its reactions. There is no basis to see those alleged currents of thoughts as being the same as what may have developed centuries later as "schools", created around distinct theories and empirical studies.

Treatments were simple and in the common knowledge of everyone. The recognition of a person as a doctor was based on the fact that he (medicine was almost exclusively practised by men) knew some healing procedures, and had used them before. They were practising their craft on a daily basis as opposed to the rest of the population, which was only occasionally faced with the need to treat diseases. However, the items and activities prescribed by doctors were commonly available and used by those who could not pay for doctors' consultations and the prescriptions they sold. The temples where the God doctor Asclepius was worshipped were open to all who preferred to resort to prayers and offerings.

Bloodletting was perhaps the only procedure that required a doctor, although a charlatan could certainly perform it too. Hippocrates did not have a favourable view of this procedure though (see Craig, 2021).

It is important to emphasize that the medicine of the first period had very few therapeutic resources to deploy. Basically, everything a doctor could prescribe or do was widely known: plants, baths, massages, purging, exercise (or its reduction), diet, abstinence from sex, alcohol or specific foods, and so on – simple prescriptions in the public domain. The doctors nevertheless were those knowledgeable about the diversity of resources. They had seen many sick people and could therefore know better what seemed to work in particular situations. Anyone who could not afford to pay the doctors could still use similar treatments according to popular understanding. Everyone had easy access to items employed in treatments by cheap charlatans. In general terms, it was also widely accepted that cure was nature's business and no treatment could succeed against its determination.

System's features

We cannot speak of health as a *social function system* in this period. Medical practice was unregulated, open to any craftsman with the inclination to claim competence in healing people. The only identifiable social system could be characterized as *interactions*, which, as explained in Chapter 2, consists of social systems that require face-to-face direct communication between the people involved. Interaction systems start and end as soon as the conversations finish. The doctor could make records of his observations, but that would not necessarily go into standardized registries or archives to be used in other communicative processes. When made, the collection of texts were intended to help with similar cases the doctor might encounter, and to aid other doctors in the cases they were called to treat, but they were not medical files as we know them today, kept for a variety of purposes such as managerial, legal, aide-memoire for follow-up.

We can identify the following aspects as being distinctive of a social health system, in an embryonic stage, taking its first steps towards social

differentiation: (1) the vocabulary (semantics) that was then becoming common currency among those who could perform the craft, endowing them with a distinct way of talking about diseases; (2) the social identification of the craftsmen as performing a valuable and distinct service; and (3) the very first initial step to circumscribe and fence the practices by promoting a self-referential code of conduct. The adoption of the Hippocratic's Oath was indeed an extraordinary self-regulatory orientation with powerful self-referential effect, revealing a self-conscious category of craftsmen motivated to preserve a distinctive character, which corresponded to the elitist nature of the literacy and expensive training required.

Still, on the treatment side, none of the promoted and practised therapeutics was enough to establish health as a social system. It can be said that in fact they would be rather a hindrance, given the fact that the treatments were of common use, making it difficult to turn them into specialized exclusive knowledge, as necessary to establish a social *function system*.

As *interaction* was the prevailing social system structure, and organizations were not set up for exclusive provision of care or control over the use and practice of healthcare, the overall configuration was in this sense loose, with widespread presence of charlatans, who did not read the texts and did not follow the observation approaches recommended in the texts.

This configuration thus fitted well with *stratified social differentiation*, in which, between the upper (dominant) and the bottom (dominated) strata, there was space for individual unregulated craftsmanship and provision of services to those who could pay for them. Among carpenters, metal workers, bakers, builders and others, doctors could find their niches and sell their services in the markets and fairs, as well as on their own premises or in patients' homes.

In conclusion, there was no health system as a functionally differentiated system. Society was not yet differentiated according to the functional principle, as it would only start to be from the eighteenth century onwards; therefore, the correspondence to existing social structures from which health could copy its social functional outlook were missing.

Complexities

Doctors were confronting a diverse range of complex signs, equipped with only simple explanatory theories, such as the four humours framework, helping them to link evidence with a rudimentary explicative model of causation of diseases and functioning of the body.

To reduce the complexities of patients' observed signs and symptoms, that simple framework was nevertheless helpful. The four humours framework also introduced the "interactive process" of moving from complex evidence seen in the body to the simple framework and vice versa, submitting the framework to "stress tests" at the same time that the observed complexities were "tamed" (or "hammered") into the schematic explanations. Such discipline of approaching reality and communicating about it turned into effective methods of dealing with complexities; the explanatory framework as well as any subsequent frameworks would have to pass the same sort of pragmatic tests, with outcomes confirming or not the correctness of the suppositions.

As autopsy could not be performed, the knowledge of internal organs was limited to what could be observed in wounds and animals; consequently, suppositions about internal organs affected by the diseases could not be disproved or confirmed after death. Medical studies were therefore left with what they could observe outside the body and make their inferences based on the four humours scheme, adding ad hoc references to possible effects related to the environment, seasons, weather conditions, behaviour excesses, and so on. The complexity of medical knowledge therefore was limited for lack of opportunities to increase it by examining the insides of bodies.

Nevertheless, the systematic recording of observations of the body and the course of the diseases produced a large quantity of records with rich and complex information. That complexity was further increased with subsequent records made by Galen and his followers, including later on the incorporation of records from the Arabic and Eastern worlds (such as India and Persia).

The complexities of the observed manifestations of the diseases are noticeable in written texts. Specific vocabulary had to be developed. De-

spite the paucity of knowledge and tools, and the limitations of what could be done with patients during examinations (touching, listening to the body's sounds, measuring were very restricted), the list of what needed to be observed comprised a long inventory. The list included, but not exclusively, voice quality; colour and texture of tongue; body temperature increases with or without shivering (thermometers obviously were not available); skin appearance (including rashes, swelling, colour, temperature, jaundice); temperature of extremities; rhythm and quality of breaths; capacity to eat and drink; appearance and quantity of faeces; appearance of urine and presence of alien substances; vomit (appearance, quantity, and so on); sweat; pain and complaints; mental state (delirium, talking nonsense, loss of reason); sleep pattern; spasms; refusal of food and loss of appetitive; appearance of eyes (gaze); sex life; exercise; excretion of the four humours (bleeding, yellow or black bile, phlegm). Observation points on the body were numerous, and the registry of empirical evidence had to be simple, direct and continuous, covering the course of the disease on consecutive days until cure or, more likely, death.

The list hints at the complexity of the approach, with many aspects to be observed. The diversity of elements and body parts represented a significant challenge to keeping comprehensive and accurate records. Diagnostics representing sets of symptoms, without describing each individually, were not available. The orientation thus was fundamentally descriptive rather than attempting to make connections between conditions, causes and treatments. It is understandable that for lack of explanatory models and actual understanding of internal structures of the organs, anatomy and physiology, not much could be done apart from describing the superficially observed signs.

Meanwhile, the number of recorded cases resulted in a sizeable collection of observations made available for those interested in studying the craft. The interested could move between the text and the patients, checking new observations against those previously made by others. The capacity to distinguish cases increased as well as the acknowledgement of other aspects still not recorded. As mentioned, the recording followed the patients throughout their illness, with daily notes.

It is understandable that the sheer mass of such records created conditions for qualitative jumps, whereby new understandings of the human body were devised to accommodate the accumulated evidence. Galen (second century), during the Roman Empire, developed more complex concepts of the functions of the internal organs inside the body. While adopting Hippocrates' texts as his basis, particularly the theory of the four humours, and preserving the prominence of observation, he expanded the sets of elements to be considered.

We can understand that as the recorded complexities of the signs of disease made their recognition easier, and at the same time required dedication to learn how to track the signals, the pressure to develop classificatory and explanatory models increased. The need of *complexity reduction* strategies included the necessity for a consistent and unique vocabulary, with terms that could be maintained and preserved in all the places where medicine was being practised, ensuring permanence and stability of the communicated meanings. Such progress could only be achieved with written texts, which could thus further increase the complexity of what was transmitted to future practitioners by selecting relevant meanings from noise.

We can say that the critical mass of complex information in this period was crucial for: (1) the creation and preservation of a specific semantic with specific prospects for communication about diseases; (2) making undeniable the need for setting up educational structures and processes to reproduce the knowledge and meanings of the new semantics; (3) strengthening the epistemological pressure (*complexity reduction*) for the creation of frameworks and theories to organize, support, explain and schematize the recorded complex observations; (4) making possible and necessary the subsequent emergence of self-referred professional activities to move forward in the direction of establishing formal institutions with self-regulation roles, separating the authentic exercises from the fake ones.

Summary of medicine self-reference: first period

We list below what we believe were the ways in which doctors would self-describe thinking and practices, and would use to identify each other as practitioners of the same craft.

- Medicine was recognized as a rational and non-religious discipline based on how to register observations of the human body and its diseases. Direct empirical observations were conducted without instruments, formalized procedures or methods of testing. Medicine developed its initial self-identity orientated to perform simple observations, describing what was seen without appealing to deities or magical influences.
- Based on accumulation of recorded cases, prognosis of how a disease would unfold could be made. The discipline of collecting reports was predominantly intended to allow identification of patterns of progress of the disease, thus making prognosis of outcomes possible.
- The interpretation of observations could refer to simple causality models: (1) the four humours with notions of balance among them and the disruption caused by excesses; (2) the doctrine of critical days, through which the diseases would follow patterns of improving and worsening, according to the number of days from the start; (3) possible influence of weather, given the seasonality of some conditions, with systematic records of the seasons and weather conditions during the course of the diseases. Galen made more complex models of the functioning of the body, though preserving the Hippocratic theoretical framework of four humours. Such frameworks comprised the main general semantics available to interpret possible causal influences, but the overall approach was mostly orientated towards describing the condition rather than explaining causes. As noted, the focus was on descriptions and prognostics.
- Medical communication was mainly between doctors and patients, and among doctors themselves, essentially those being trained and their masters. Doctors would teach apprentices about the craft, and were paid for that, in the context of their own practices, without

formal regulation of training and certification. Medicine's self-reference therefore was constructed and reproduced through those contacts, whereby doctors would self-observe what they themselves were doing and writing about. No overseeing institution, internal or external to the field of medical practice existed.

- Doctors could practise their craft as other craftsmen would – that is, in marketplaces, at fairs, in the houses of the patients or workplace of the doctor, if they had one. Medicine was thus recognized as a service provided for a fee, like any other business, on an individual basis from doctor to patient.
- Therapeutic use of plants, diets and other resources were common knowledge. The widespread assumption was that nature had the monopoly on healing powers; only it could heal or otherwise, and healers were only supporting actors. There were no controls or regulations over the treatments, or specific settings or sites. Plants were known to everyone and not specifically produced or controlled by any system. Doctors could cultivate medicinal plants in their own gardens and produce the medicines they used in their practices; there was no restriction in that regard either. Therefore, preparation of doctors' own medicines was part of medical practice. Doctors could also acquire plants from regions they visited; travelling doctors with medicinal herbs and other resources carried from places they had previously been was a feature of medicine self-reference – travelling doctors recognized themselves and were recognized and valued as such by the population and authorities.
- The importance of following the code of conduct (Hippocratic Oath and Aphorisms) was introduced as self-regulation of the practices, providing a self-reference base and identity for those engaged in medical activities, independent of legal or religious norms. However, following the oath in practice was left to the discretion of the doctors with possibly only scant mutual observations among those practising the craft together. The oath probably had some effective regulatory role among doctors who knew each other, but it would not prevent a doctor from moving on to practise elsewhere, when caught doing something against the principles.

Second period (from the fifth to the fifteenth century). Medicine of books, universities and hospitals

Characteristics of the second period

What fundamentally distinguishes the second period from the first are the effects of unprecedented accumulation of recorded observations of diseases, which started in the first period and continued throughout the second. The descriptions were compared, analysed and checked, with systematic collation of observations of patients and text descriptions, from the text to the body and back to the text. New descriptions were made. The availability of such rich materials generated complex views of the human body. Built on the Hippocratic Corpus and his own observations, Galen's contributions at the end of the first period were diligently preserved and studied throughout the second period and beyond, for almost two millennia. This period also saw the establishment of institutional innovations of great relevance such as medical schools and hospitals.

The ten centuries from the fifth century AD (after the fall of the Roman Empire) up to end of the Middle Ages (fifteenth century AD), could be divided into two sub-periods: the early medieval period, with no significant progress in the European region, and the late medieval period, with the establishment of medical schools in universities.

In the first five centuries, known as the "Dark Ages", many scientific achievements regressed to previous stages, with strict control of the Church upon the expansion and dissemination of scientific knowledge. Medicine returned to superstitions and the Church's endorsed assumptions that health was God's business and therefore ailments were to be accepted as such. In terms of provision of curative services, during almost the entire period anyone could claim to be a healer and sell services without the Church's consent, let alone endorsement.

In the European Middle Ages, however, medicine did not disappear and continued to be practised as a craft, in the same way as previously, using plants, massages, bed rest, heat, gentle exercises, cupping, purging, bloodletting, and so on. Tolerated by the Church, practitioners were

less concerned with observing and recording cases, in contrast with the procedures started by the Greeks.

However, also characteristic of this time is the appearance of charity "hospitals" – Church-sponsored places to accommodate the destitute in general, including the poor, the sick, pilgrims and those with nowhere else to go, with everybody gathered in the same spaces. These "hospitals" were often attached to monasteries, and assistance was provided by monks with some medical knowledge, without the specific objective of studying and systematically treating diseases. The monasteries had their own medicinal herb gardens for those in need of remedies, thus preserving valuable knowledge. Around the middle of the second period, by the tenth century, more advanced establishments, specifically characterized as places for medical assistance, appeared in the Islamic world.

While medieval Europe lingered on through the dark ages, progress was made in Byzantium and Alexandria (where copies of the original written Greek and Roman documents were kept), and beyond that particularly in areas of expansion of Islamic civilization, with an important increase in medical reflection and production of written works. Baghdad, Damascus and Cairo, centres of the Islamic world and fertile ground for the advancement of medical knowledge, saw writers and historical figures such as Rhazes (with advances in differentiation of diseases), Avicenna (with his *Canon of Medicine*, still used in traditional Islamic medicine) and Averroes (with encyclopaedic texts covering all known medicine at that time). These writers were prolific, producing dozens of written works, mostly strongly influenced by the Greek texts and keeping the prominence of direct observation. Many of the texts did not survive the period though.

Back in Europe, in contrast with the Church authority and restrictions on doctrinaire grounds, the first sub-period is also characterized as "library medicine" by Bynum (2008), highlighting the major contribution to medicine originating from the preservation of copies and translations to Latin of the original Greek, Arabic and Persian medical texts. Such activities were mostly carried out in monasteries by monks, and later on in universities. The reproduction of those materials by hand in the monasteries was crucial for the preservation of the knowledge thus far gath-

ered. Although dissociated from any systematic process of transmission or teaching, the preserved materials became crucial for the later education at medical schools in the universities. The preservation of texts set the basis of a complex field of knowledge and exclusive competences.

In the second half of the period, the recognition of monastery hospitals as spaces for medical studies transformed their outlook and accelerated the process of gathering observations and descriptions of diseases, contributing to the characterization of doctors as having distinct a social role with distinct social spaces for practising.

When in early medieval times (thirteenth century) the Church forbade clerics from getting involved in the practices of medicine, most specifically surgery, due to the uncomfortable contrast with religious teachings about preservation of the integrity and untouchability of the human body, medicine was progressively detached from the Church. Without that barrier, medicine fully entered the scientific domain as knowledge to be learned at universities, creating the possibility of linking the existing monastery "hospitals" to universities' medical courses for treatment and study of diseases. Such processes became crucial for the eventual acceptance of autopsies as a method of learning about the body, the diseases and the causes of death, with the first medico-legal autopsy carried out by Bartolomeo da Varignana in 1302, and first public dissection for anatomic studies performed by Mondino de' Liuzzi (around 1315) Bologna.[2]

The first recognized medical school was established in Salerno (in the eleventh century), followed in the subsequent century by the schools of Montpelier, Padua and Bologna. Salerno gathered a small number of students and teachers, but found a more open terrain for reflections. Two centuries later, schools were established in France and in Spanish cities.

2 Although there are historical references to autopsies conducted in Alexandria in the third century BC by Chalcedon, the references to autopsies in animals and humans by Galen (second century), and the anecdotal story of the post-mortem examination of Julius Cesar, including identification of the fatal stabs, the practice was largely forbidden in the first period.

In the Islamic domain (from the eighth to the fifteenth century) in Cordoba and Toledo, medical manuscripts were translated into Latin.

The medical schools of the period were mostly dedicated to studies of the classics, and educational processes involved discussions, debates, speculations and interpretations of the texts, with little in the way of practical exercises or generation of additional medical knowledge. Nevertheless, the model of medicine-in-universities spread out and several schools in medieval Europe introduced medical courses towards the end of the period. By the twelfth century, medical schools existed in the universities of Paris and Oxford. According to Bynum (2008), by the late fifteenth century there were 50 medical schools in Europe.

Still, training was only for those who could afford to pay and gain access to copies of the texts. Although texts started to become available in Latin and copies were produced in larger numbers, they were not yet printed. However, as the required literacy was only possessed by the privileged few, only a small minority could have access to and read the texts.

The last centuries of the period (fourteenth century) saw huge plague epidemics, which had devastating effects on Europeans, with deaths estimated as ranging from 25 per cent to as much as 50 per cent of the European population. The epidemics nevertheless brought concrete initiatives for controlling and preventing outbreaks, although still without any knowledge of infection and transmission processes. The measures consisted mostly in controlling access to cities and regions by foreigners, disposal of dead bodies and rudimentary quarantine methods, which nevertheless was undoubtedly the beginning of public health. In fact, some of those measures had already been put in practice centuries before during epidemics in the Greek and Roman worlds.

System's features

Similar to the previous period, *interaction* between doctors and patients was the prevailing social system seen during these ten centuries. *Organizations* as social systems were not set up for provision of care or control over healthcare resources; the existing organizations were rather religiously sponsored charity "hospitals", for accommodating all sorts of in-

dividuals, the sick as well as the poor, pilgrims and homeless alike. These "hospitals" were not medical organizations. It was only by the end of the period that hospitals started to become distinctive institutions where healthcare was systematically carried out. Links to university medical courses also started then.

From the social systems perspective, we see a combination of those three major developments: the preservation and translation of medical texts; the opening of university courses; and the recognition of hospitals as sites for caring for the sick. These had determinant effects for the development of conditions for the constitution of health as a social system.

Concretely, these points can be emphasized: the texts further deepened and expanded the exclusive semantics and specialized language; the hospitals made possible the social recognition of practice of addressing diseases in institutionalized settings using professional expertise; and the universities' medical courses initiated the possibility of a clear distinction between those who could and those who couldn't appropriately claim the right to practise the craft, building the pathways for selective membership in the future health system. All three contributed to set the preconditions for the system.

Exclusive texts, specific universities' courses and hospitals moved medicine in the direction of a system with its own codes, and corresponding autonomy for self-reproduction of codes and communications. These innovations brought about reproduction of practices and reproduction of knowledge through organized communications among peers and students.

Medicine started to enjoy an exclusive privileged environment for communicating about the human body and diseases, protected from external interference, and at the same time achieving social recognition and legitimacy for claiming and using such social spaces. In this still unstable but already exclusive domain, medical models and frameworks could start to be discussed, doubted, criticized, revised, tested, retested and approved or dismissed. That was fundamental for the future emergence of health systems.

Other medical currents of thought, such as those developed in the Islamic world, found a place for recognition and further consideration.

In the Salerno school, for instance, although in the area of influence of the Church, there was openness to studying medical texts of diverse origins such as Greek, Arab or Jewish. Constantine the African was a key figure in translating several books into Latin in Salerno. With that we see medicine taking critical steps towards assessing and comparing paradigms in a self-referential movement that could not be carried out outside medicine itself.

Towards the end of the period, an additional step was the establishment of organizations such as the medical guilds, in the same model as the guilds of other crafts. These organizations played the role of self-regulators, preventing strangers from introducing illegitimate codes and meanings from other fields into the realm of medicine, thus averting disruption of the practices commonly agreed among doctors. Such interference by strangers could be detrimental for the recognition of medicine as a valid, valuable and well-defined field of practices and knowledge. The guilds created decisive fencing for the systemic closure, accepting as members only those who had completed university training. By the same token, the guilds represented a significant experiment in self-regulation to subsequently take more legally and institutionally consequential roles.[3]

Until the appearance of medical guilds at the end of this period, the context was of deregulation and laissez-faire, with both charlatans (without medical training and knowledge of the medical texts, mixing healing practices with religion and superstition) and doctors profiting from business opportunities. A health system as a functionally differentiated system could not find a base in such a context of general deregulation and openness. However, although weak, self-reference among doctors who had access and studied the texts was developing into self-recognition of a distinct valuable practice. Such self-references were conducive to subsequent broader social recognition.

The opening of schools of medicine at respected universities a therefore major impact on the self-reference of medical expertise, becoming

3 On the medical guilds, see McLaughlin (1941).

not only crucial for self-identity but also for establishing common recognition of medical knowledge and practices as distinct, unique, scientific and complex. This was of vital importance for the self-reference of the practising "communities of professionals", a condition for identifying themselves as holders of uniquely privileged knowledge. Fundamental elements for a functional health system were thus launched.

Complexities

The numerous descriptions of cases of disease gathered over the previous centuries embodied formidable complexity, exposing and pressuring the limits of the existing interpretative and explanatory frameworks. With details of diseases increasingly described and the new semantics revealing complex observations, the use of the by then extensive vocabulary became progressively more exclusive to a limited number of those who could read and communicate the meanings. As already noted, this process culminated in and took decisive direction with the opening of medical courses at universities, which both constrained access to the specialized language and strengthened its usage among professionals, thus creating conditions for increasing the complexity of medical narratives.

Among the examples of how the accumulations of case descriptions led to more sophisticate explanatory models are the representations established by Galen in comparison with Hippocratic texts. Although Galen still preserved the four humours framework, his texts included more elaborate descriptions of the circulation of blood through the liver, heart and brain, considered the most important organs of the body. The focus of attention therefore started to divert from humours to the organs; that turned out to be a decisive move in the direction of locating diseases in the solid organs instead of volatile fluids.

Medical knowledge was thus striving to incorporate the observed complexities into its descriptions. The frameworks adjusted to the complex observations, opening the possibilities to more complex ones. In a way, the semantic system became prepared for supporting communica-

tion of huge complexities continuously unveiled, once the restrictions over dissection were lifted and looking inside the body was permitted.

As said, the complexities of the bodies could start to be addressed more thoroughly in a consistent and systematic manner as medicine found a place for communicating about complex observations while studying patients and corpses. The universities offered sites for discussions in parallel with the expanded opportunities for diving deeper into the body that the hospitals provided. In short, as a result, medicine was preparing to become more complex in its conceptual and semantic arsenal; complexity was developing in the two sides: the observed bodies and the words assembled to communicate it.

Furthermore, the adoption of the organizational model of guilds (similar to other crafts in urban centres) signalled the potential for reduction of the complexities of a multitude of practitioners performing their craft without any common, consistent orientation and supervision. The delimited gathering of doctors enabled continuous mutual observation and allowed knowledge harmonization. Instead of each one acting as they individually wished, the importance of collective confirmation and acceptance of the procedures and corroboration of what each was doing became clear. Reducing the complexities of uncoordinated and "free-for-all" professional practices, and establishing a sense of collective identity, prevented the chaos that could have prevailed.

Summary of medicine self-reference: second period

- Medicine in monasteries: Initially subordinate to the Church view that health was God's business, medicine in monasteries was medicine for members of the Church, for the privileged few who could afford it, provided in a comfortable setting (with access to the herbs cultivated in the monastery and good accommodation), as well as medicine as a charitable service for the dispossessed, mixing rudimentary treatments with general support for living. That was a rather simplistic notion of medicine.
- Medicine as knowledge of the body as described in copied texts of the previous period and translated from diverse languages and geogra-

phic origins (Indian, Persian and Arabic worlds), strongly influenced by the Hippocratic Corpus with Galen's additions.

- Medicine taught in a few newly established (eleventh century) university courses, to train small numbers of those who could read and write texts in Latin – the medicine of literate and university-trained doctors.
- Medicine in hospitals initially created for wounded soldiers and later on opened as charity for the needy (poor, sick, pilgrims, homeless) and also victims of epidemics. Hospitals not as medical institutions, attached to monasteries, but progressively linked with university courses.
- Towards the end of the period, medicine as science authorized to perform dissection and studies of anatomy on dead bodies in universities and hospital settings (University of Bologna fourteenth century).
- Medicine as an increasingly complex practice of university-acquired competence; gradually circumscribing and limiting access for those willing to practise, setting limited terms of acceptability on the craft and the entitlements and responsibilities for medical knowledge reproduction.
- Medicine of the newly established guilds, bringing together doctors in associations of common interests, intended to protect the craft from external interference and charlatans, adopting the organizational models of guilds of other crafts in urban centres. The guilds contributed to reducing the complexity of a multitude of practitioners performing in isolation without coherent and consistent orientation or knowledge sharing.
- Medicine of publicly recognized and approved medical professionals, differentiated from the barbers/dentists/surgeons category, considered inferior crafts for their close physical contact with customers/patients and their poor training.

Third period (from the sixteenth to the eighteenth century Reformation, Renaissance and Enlightenment). Medicine of the visible inside the body; medicine as science and technique

Characteristics of the period

The third period progressed through a time of scientific knowledge expansion in all domains. The rational roots of the Enlightenment were found in all fields of science. Medicine was part of this overall trend, integrated into the spirit of the times. At first, the Renaissance aimed at resurrecting the values and reflections of the classical period, distancing the endeavour of knowing from the directives of faith, a separation to which the Reformation strongly contributed by bringing about alternative viable faith expressions not subordinated to the Church – in fact confronting the Church's monopoly on the truth about the world. The Enlightenment that subsequently unfolded brought the promise of reason and empowerment as the ultimate way of knowing the world in all its complexities.

This was a period of remarkable advances uncovering the body's structures and functions. In those three centuries, far more was added to medical knowledge than in the previous two millenniums. This was also a period when scientists made their discoveries individually, finding international prominence, setting in motion a virtuous cycle in scientific communities, encouraging new studies and investigations. There were intense and continuous exchanges between centres of studies in the main European cities (and later in America), with scientists often spending time studying or teaching in different countries.

By the seventeenth century, with the vast collection of studies of anatomy, physiology, biochemistry, and such, the systematic classification of disease had become a pressing issue. The concurrent progress in the classification of animals and botanical species offered an example of successful models. Ultimately, diseases could perhaps be classified as distinct metaphoric "species", so some tentatively thought.

The appearances of several nosologies were witness to the great efforts to come to terms with the huge varieties being uncovered. It was necessary to schematize and reduce complexities, "controlling" the increasingly diverse assortment of identified symptoms and signs into manageable classifications. Diseases were placed in the organs rather than on unbalanced humours as in the previous two millennia. Classifications thus were crucial for guiding the approaches to recognizing diseases and communicating about the category of disorders being dealt with as well as the respective treatments.

However, the curative resources did not advance as much as the knowledge of the body. Medicine as therapeutic practice used the same tools for treating the recognized illnesses (diet, bloodletting, laxatives, purging, enemas), although now enriched with new plants and herbs (such as quinine) from newly discovered continents. The radical evolution of treatment methods and resources had to wait for the major breakthroughs to happen in the next period.

At the end of the second period, the invention of printing had an immeasurable impact on the transmission of knowledge from which medicine reaped enormous benefits from this third period onwards. The mass reproduction of medical books and the widespread launching of university courses as standard for medical training contributed decisively to the irreversible consolidation.

Medical semantics were thus systematized and universalized, unifying the field into a worldwide single corpus of meanings. Across the world, medical students would learn from the same texts, written by the same renowned authors. Medicine thus consolidated social recognition as universal knowledge and a professional field.

This period therefore can be characterized as the consolidation of scientific_medicine on three pillars: the growth of university courses and academic medical studies; the mass production of medical books (now translated into European languages); and the expansion of hospital-based treatments with the establishment of hospitals for exclusive treatment of specific diseases.

Medical knowledge acquired more complex explanations about the functioning of the body and the alterations caused by diseases; this was

possible with the expansion of studies of anatomy, physiology, pathology, pharmacology, and so on (see more detail in the section on medical self-reference below). Among the contributors, the names of scientists such as Andreas Vesalius, Paracelsus, Thomas Sydenham, Marcello Malpighi, Herman Boerhaave, Giovanni Morgagni, William Harvey and many others can be highlighted.

With university courses, books and medical hospitals, the medicine of the period became "medicine of the visible inside the body", with a newly developed arsenal of observation tools and techniques, venturing beyond the surface where it had previously been confined. The use of microscopes; the invention of equipment and tools such as thermometers; the practice of dissection becoming routine and making it possible to complement diagnosis with observations after death; the establishment of routine procedures of ward visits by the head of the clinic followed by his students, are just a few examples of numerous developments strengthening the impact of the combination of those three factors: university courses, books and hospitals.

Medical guilds as forms of organization and protection of doctors and medical practices expanded and started functioning in several European countries. Regulations and formalization of processes of authorization for practising medicine brought about the final steps to make the field exclusive to qualified professional practice.

The epidemics of the time (such as the plague, from the fourteenth to seventeenth centuries) started to be addressed using scientific methods with better and more systematic understanding of epidemics and hygiene measures to control them, although still without the crucial knowledge of vectors, transmission and infection. Also on social application of medical knowledge, the first empirical attempts at what would later become mass vaccination took place by fortuitous experiment with self-inoculations by Edward Jenner with smallpox in eighteenth-century England, opening new horizons for the social impact of medicine and the constitution of public health.

System's features

Medicine's relevant systemic features acquired in this third period prepared the finalization of the health system by creating strong self-reference, dedicated social space for intensified exclusive communications, and self-identity for autonomous self-reproduction. More specifically, the important developments for final health system differentiation were:

1) Development of complex exclusive semantics to communicate on matters related to:

    - Understanding of the body's functions and structures, and disruptions provoked by diseases;
    - Links between evidence (signs and symptoms), the corresponding affected bodily structures and functions, and treatments;
    - Design of nosology (disease classifications) based on anatomical and physiological knowledge (while aetiology was not yet developed).

2) Establishment of university courses and social consolidation of the expertise as distinct and socially relevant, making possible the social selection of who was and who was not allowed to practise medicine, based on knowledge and capacity to communicate using a recognizable vocabulary and the possession of valid certificates. The communications thus reproduced represented a solid legitimizing standardized base. Where the conditions for those communications were set up, observing and adopting the same consolidated references, medicine sub-system (and later on health systems) was able to emerge. Medical courses made medical self-reproduction effective; doctors were teaching future doctors on matters that only doctors could communicate about.
3) Spreading over Europe, the organization of medical guilds as protectors of the craft, defining the limits and conditions for medical practice, constituted forms of association and self-regulation, pro-

gressively becoming instrumental for representation and self-identity in interactions with political systems.

4) Confirmation of designated social spaces (hospitals) for medical practices alone. The establishment of hospitals as entities of public interest, with political and financial support, had a profound systemic impact. Doctors would no longer work only as independent individuals at the bedside of those who could afford to pay them. The expertise was intended to benefit the whole society. Hospitals were exceptional sites for the increase in complexities, both of observed and treated diseases and of the exclusive communications by doctors. Hospitals concentrated in the same space a large number of sick people with diverse conditions, thus also facilitating the concentration of professionals. Doctors would have (as they still have) a lot to discuss among themselves about the patients. Daily discussions and education sessions with presentation of cases to large audiences of professionals and students became part of hospital routines. Communication-based social systems largely depend on the continuous intense reproduction of communications.
5) When the health system stabilized as a function system in the following period, it could assimilate internal differentiations in specialities and other professional fields that started to become accepted during the third period. The third period showed progressive incorporation of additional professional practices, which later would become fully differentiated specialities or health professions. That happened with the initial steps in the direction of recognizing surgeons, nurses, dentists, pharmacists, and so on, each with their communications and semantics, as valuable parts of healthcare service provision.

With all these levels of complexity, the embryonic social health system was establishing boundaries and becoming fully in charge of its own reproduction. The system's life was reliant on its self-observation, self-regulation and self-reproduction, all realized and sustained by the increase of communications among doctors.

However, to become a function system it was still necessary to develop external coupling with other differentiated systems. For that matter, the political and legal systems were being activated on matters of health as being of socio-political relevance. The health social system therefore began to emerge. The French Revolution was a landmark in that regard, with public policies issued regarding public health concerns, organizing health service coverage and entitlements of the population (see later). Although the conditions were set, the health system nevertheless only emerged in the subsequent period.

Complexities

To address the complexity issue for this third period we need to briefly recall some theoretical definitions presented in Chapter 1 and add a few more points. Complexity refers to more elements and relations than a system can handle; the system recognizes its inability to observe excessive numbers of elements and relations in its internal and external environment. So here we refer to complexity as reflecting two aspects: the elements and relations medicine in the third period recognized in the body and in diseases; and the composition of medical self-reference in the midst of massive advances in knowledge of the body, or in other words, what medicine would see as its tasks.

Complexity and causes

Up to the end of the period in the eighteenth century, medicine accumulated substantive knowledge about the internal structures and functions of the human body, and also identified transformations associated with diseases. The rational medical approach linked disease symptoms with pathological signs in affected anatomical structures. Descriptions of these structures, and descriptions of observable functioning and visible transformations in the organs, were rich and detailed.

However, basic causal relations remained undetermined or weakly suggested. Where a causal relation would eventually make the phenomenon comprehensively understood, all that was available then

offered only room for speculation. With the knowledge of cells, germs, genes, biochemistry, molecules, hormones, and so on still to be developed, the medical understanding of causality was limited to very simple explanatory models, such as that a single cause would produce all diseases, or that external factors such as the stars, the "miasmas", were the causes of diseases – not very far from the schemes the Greeks had already suggested with the four humours.

There were also some more sophisticated theories suggesting the balance of external stimulations and excitation of internal organs, as well as the tuning of vital energy flows inside the body with tension in the fibres. Furthermore, others indicated the causes of the diseases could be found in the organs and their tissues.

Medicine today has a wide range of causal relations linking pathological signs and symptoms to alterations in organs, tissues, cells, physiological functions, and so on, which can be authoritatively clarified using a large arsenal of tests and examinations. That was not the case then. The causal links between the visible complaints/alterations, and the deeper structures and functions involved were not understood. Crucial measurements and detection instruments had not yet been developed, leaving large gaps in presumed causal links. For example, there were no ways of finding out that the conditions seen in advanced diabetic patients were caused by the increase of sugar in the blood, which would not be recognized.

Multiple-causation was an even more distant consideration, due to the lack of methods and instruments for separating the effects of different factors. In addition, the natural variability of all biological phenomena could not be understood as possible expressions of the same disease, being therefore wrongly interpreted as distinct.

It can be argued that the knowledge of causality has two effects. First, it can reduce complexity, filling gaps and reducing the known unknowns as far as relations are concerned, as it identifies reasons for linking otherwise apparently disconnected observations. Secondly, acknowledging potential causal relations may bring about complex considerations of different factors and different possible connections for the same observed effects. Thus complexity is not ruled out once

plausible causes are considered; it rather acquires a new configuration in correspondence to the variety of causal explanatory models available in the context. Causal links can indeed be highly complex to determine and reconcile with alternative explanatory models.

In the third period, though, we see an open field with multiple possible questions about causes of which there were hardly any satisfactory answers. Explanatory models could not be developed, as many causal factors had not yet been found. In this sense medicine in the third period was still describing diseases, although with a richness of detail that had not been seen before. Each organ was being studied individually and those studies included morphological alterations observed in autopsies, without revealing causal processes.

Self-reference and complexities

Another way of approaching the issue of complexity in the third period is related to the complex articulation of self-references. During this third period, the self-reference of medicine had to incorporate new meanings arising from the knowledge being produced.

The new findings had implication for the way medicine could define itself; the doctors could for instance say that medicine was no longer about the four humours and instead it was about the lesions anatomically described with possible alterations in the respective functions. The new discoveries thus changed the descriptions doctors would make about their knowledge and consequently their job. From the point of view of the time, these implications were rather complex.

In a broad sense, self-reference has to handle the complexities of its own nature with the evolving meanings. We can say that a function system based on communications and meanings is restless in its continuous efforts to maintain its self-reference. It cannot be otherwise. Once a system is set up to refer to itself according to a certain selection of meanings, it creates the need to reaffirm the selections at every instance.

Complexity arises out of the very existence of a multiplicity of possible selections that are constitutive of meanings (Luhmann, 2023).[4] Complexity cannot be avoided or eradicated in face of the multiplicity of meanings available. But it can be temporarily "tamed", so to speak, with meaning-construction operations by which only certain meanings are selected and the other possible ones dismissed. That is how meanings are generated and communications can communicate them.

Complexity is therefore temporarily sent into the background, still nevertheless offering the contrast that makes visible the selected meaning. As there is no self-reference without meanings and selection of meanings, complexity is the very basis on which self-reference is built. This theoretical structure should help us to understand this aspect of the progress of medicine in the third period.

In the history of medicine there are several examples of very important breakthroughs that had nevertheless to wait years before being recognized. These are examples of how obsolete self-references are maintained sometimes even at the sacrifice of relevant innovations that supposedly could bring about severe destabilization of the whole conceptual building thus far assembled. An example of that was Edward Jenner's experiments with self-inoculation of smallpox; the Royal Society declined to publish his paper describing the procedure (Bynum, 2008, p. 74).

The complexity of the self-reference of medicine encompasses all the scientific and technical advances that were happening. Each advance unfolds into questions of what medicine is and how it should be seen. We can consider, for example, that medicine was reformulating its all-inclusive identity, assimilating the advances in scientific fields such as anatomy, physiology, pathology, and the notions of pharmacology, infection, histology and others. The complexity resided in carrying on with the subdivision in different areas while keeping the sense of integration and articulation between all the distinct divisions. The internal divisions

4 In the book *The Making of Meaning*, particularly in the second chapter "How is social order possible?", Luhmann (2023) extensively develops the conceptual architecture of the interconnectedness of the concepts of complexity and meaning.

could in fact enrich the sense of medicine as a unit, as a condition and support for the recognition of increasing internal variety. Paradoxically, the internal diversity did not destroy the sense of unity, but rather strengthened it. We can say the strengthening effect arise from the fact that the new specialized knowledge kept the same fundamental binary distinction (healthy/sick) in place.[5]

Besides that, the description of pathological phenomena, particularly anatomical and physiological features of pathologies, provoked intense reflections on the meanings of the normal and the pathological and where one started and the other ended. The topic was at the heart of the self-definition of medicine as exclusively concerned with diseases (the pathological). Apparently, the solution to the normality problem would allow deciding when an individual would become a patient, and therefore an object for treatment and medical studies.

Although the formal notions of normality and pathology seem to dress the topic in a simplistic outlook, in fact the location of the boundaries and characterization of the two opposite sides and how it was possible to move from one side to the other of the distinction was highly complex. Whether pathology was only an exaggeration of normal physiology, or normal physiology with different intensities, or whether they were totally separate biological conditions, are examples of the kind of questions at the heart of the considerations of "so, actually, what is medicine?" Is normal physiology also something of interest for medicine? Why? (Canguilhem, 1978).

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5 In Luhmann's terms (2007, p. 43), each partial system (and we may see a medical speciality as a sub-system of medicine and a part of the health system) replicates, co-realizes and reinforces the overall system (the health system) through its own specific system/environment difference (being the system reproduced as speciality or sub-speciality, with the environment being the field of concerns of the speciality in the environment of the system – specific functions and organs in the human body). In other words, medical specialities reinforce the sense of unity of medicine because any speciality reproduces the same binary distinction healthy/sick prerogative of the medical sub-system and is validated as such.

This topic will be treated more extensively in the section on Canguilhem in Chapter 5. For our current discussion our message is that in the third period medicine was asking about its own identity in complex ways. For those potentially disturbing polemics about the normal and the pathological, medicine had already conquered its internal space, and it could afford to discuss its identity at length. Medicine could work out the means of its reproduction within medical schools and fields of practice, even while confronting fundamental questions about itself.

Medicine was increasingly becoming medicine's own business and no one else's, and could face the self-criticism and the internal doubts it was itself creating. The next section gives a more detailed picture of the diversity involved.

Summary of medicine self-reference: third period

Considering the complexity achieved in the third period, it is relevant to add another brief aspect of the theory of self-reference. In Luhmann's theory, self-reference is second-order observation, as it consists in observation of an observer by an observer – in this case, the observer itself. We recall that social systems are self-referential autopoietic systems. Given the complexities of the knowledge gathered in the third period, self-reference was set in continuous and self-reinforcing motion with proliferation of sites where doctors could observe other doctors and through communication select and generalize what all doctors were supposed to know and do. The reproduction of medical meanings required self-observation and communications in the context of the self-reference. This became increasingly systematic as the medical training expanded and covered many years of professional life. We list below the points of self-reference that were established during the third period:

- Medicine's self-referential entitlement to look inside the body: Medicine could recognize itself as in charge of accompanying the patients over the course of diseases, from the bedside to the morgue, establishing clinical-pathological correlation and gathering evidence

of the presumed pathological processes. Autopsies became medicine's business.

- Medicine of the recognized scientist doctors, researchers of an advanced science, with command of scientific methods, observation tools, experiments, working in academic institutions, developing new models of the body and internal functions, expanding knowledge in several directions. Among some of the new fields of studies and most prominent scientists were:
  1) Medicine of anatomy (Andreas Vesalius, sixteenth century, established anatomy and physiology as independent disciplines, developing complete anatomical descriptions still used today);
  2) Medicine of physiology (William Harvey, seventeenth century, described the circulatory function);
  3) Medicine of pathology, physiopathology and pathologic anatomy; (Antonio Benivieni, fifteenth century, verified pathologic evidence with autopsies);
  4) Medicine of contagion and infection (Gerolamo Fracastoro, sixteenth century, made the first proposition of the concept of contagion by invisible particles entering the body after contact with a sick person or contaminated material; Ambroise Paré, sixteenth century, proposed a number of inventions related to antisepsis for surgical procedures);
  5) Medicine of chemistry, toxicology and pharmacology (Paracelsus, sixteenth century, developed proposition of dynamic views of medicine based on chemical elements as vital force of the organism, specifically mercury, sulphur and sodium);
  6) Medicine of microscopy and medicine of histology (Marcello Malpighi, seventeenth century, performed initial studies of microscopic anatomy);
  7) Clinical medicine, linking clinical observation of signs and symptoms and anatomic lesions at the level of tissues during the seventeenth and eighteenth centuries, including: development of nosology (Thomas Sydenham); classification of diseases with expression of symptoms in individuals (Boissier, Cullen); clinical observation of anatomical lesions (Morgag-

ni); histopathology and diseases in the tissues of the organs (Bichat); treatment horizons and the notion of clinical trials (controversies between Pierre-Charles-Alexandre Louis and François Broussais over chances of curing diseases, particularly bloodletting, using rudimentary statistics);

8) Medicine of instruments (Laennec, eighteenth century, invention of the stethoscope, establishing auscultation as clinical method, and the thermometer).

- Medicine self-assessment of its own references: The period saw medicine becoming capable of judgements of what medicine should or should not be concerned with, in a self-coordinated all-encompassing fashion. Doctors became interested in knowing how accurate the identification of symptoms and corresponding diagnosis hypotheses were, by confirming them (or not) through post-mortem examination. Medicine needed to confirm its understandings for itself. For example, self-assessments led to acknowledging that the theory of humours was not enough to explain what was being uncovered in the bodies; better explanatory models were necessary. In this process, medicine was thus observing itself formulating ways of observing; it was observing how it was observing. The new findings brought to light had to be tackled in more complex ways. Paracelsus strongly dismissed Galen's and Avicenna's theories previously admitted as unquestionable; this was a clear example of self-assessment and self-reference dynamics in action.
- Medicine and the semantics to communicate about the body and diseases became admittedly highly complex, not only through the increase in descriptions of organs and diseases affecting them, but also because of the above-noted self-assessments, by which the semantics required preservation and strict rules of presentation and argumentation, subject to continuous reviews. It was not enough to use the correct words but also the conditions and criteria of validity of their use were required in academic settings (this self-reference was new in the history of medicine).
- Medicine of the universities: Medicine could not be practised without formal training in universities or academies of science. Legally

regulated as a profession, self-regulated in its contents, and concerned with the increasing complexity of its field, medicine needed to rely on elected mechanisms to self determine what was or was not valid knowledge and practice to be taught in the courses, and subsequently be verified throughout the professional life.

- Medicine of committee, councils, royal academies and collegiums: While universities were appropriate sites for educational purposes, medicine had to establish itself in institutions for permanent monitoring and preservation of the self-reference beyond the training period. This self-regulatory aim was progressively accomplished with the institutionalization of regulatory bodies. An example is the Committee "des Secours public" during the French Revolution (Foucault, 2003), concerned with public assistance, sanitation of hospitals and prisons, health policies and public hygiene. Another example is the "Regia Sociedad de Medicina y outras Ciencias" in Seville (seventeenth century) (Barona-Vilar, 2023).
- Medicine of complex hospitals: Hospitals became important for preparing the emergence of the health social systems. They provided unique sites for complex self-reference related to both observed and treated diseases and the semantics doctors were using and further developing for their exclusive communications. By concentrating large numbers of sick people with diverse conditions, the communication among professionals increased to levels it would never have reached if the patients were geographically dispersed and doctors had to travel to see them individually in their homes. The number of patients seen in a day became significantly larger along with the number of professionals able to check and discuss the same patients. Doctors met in wards, corridors and examination rooms, and talked about their patients. They met in daily formal education sessions, for the presentation of cases and discussions with large audiences of colleagues and students. Hospitals became crucial for the development of health as a social system, not because of the structures, resources or investment, but most importantly because of the exponential increase in communications among professionals they made possible.

- Medicine of the social, hygiene and epidemiology: At the initial steps of approaches such as prevention, hygiene, water and sanitation, politics of health, vaccination, and so on, these advances were crucial in broadening the concept of medical science as responsible for looking not only at individual patients but also at the health of collectivities. Johann Peter Frank's (eighteenth-century) "System of a Global Medical Policy" is an example of this progress. Edward Jenner (also eighteenth century), although still without the germ theory, tested inoculation for smallpox, opening the door to vaccination and immunization. Public health then began to set foundations for focusing on the health of populations, on the collective risk factors and on social distribution of healthcare services provision.
- Surgery was incorporated into medicine: At early stages in the period, surgery became recognized as knowledge and skills akin to medicine, in contrast with the previous understandings classifying barbers and surgeons in the same professional category. Barbers and surgeons shared the same status over the course of centuries until the third period. With the advances in anatomy and knowledge of the internal structures of the body, surgery was then upgraded to the category of medical practice, leading to important developments of anatomy for surgery and surgical procedures. The establishment, for instance, of the Colleges of Surgeons in Paris (eighteenth century), London (1800) and Cadiz (eighteenth century) marked the change. Such advances brought surgery definitely into the area of medical self-reference.

Fourth period (from the nineteenth to the twenty-first century). Medicine of the invisible made visible, medicine of specialities and medicine of the health systems

Characteristics of the period

The advances in medicine in this last period were extraordinary. The understanding of diseases' pathological processes, causes, curative and preventive interventions, were astonishing. Listing the progress would require an encyclopaedic approach, which is beyond the scope of this book. We therefore highlight here the most consequential advances and discuss their links with the final establishment of health as a social system. In the last section (summary of the self-reference of medicine in the fourth period) there is an attempt to group distinct categories of advances.

Parallel to the continuous progress there has been continuous rethinking about the nature of the diseases, as new sorts of causalities were uncovered in association with large diversity of factors. Clinical trial methods, tests and analysis, with sophisticated measurement devices and powerful statistical and processing techniques, entirely changed empirical approaches. Medical studies and research became large-scale endeavours involving much expertise and resources. The equipment and pharmaceutical industry experienced exponential growth at the forefront of innovation with new advanced products, continuously changing the scenery of therapeutics and availability of treatments.

In the previous period, it was already clear that there was no longer a single cause of all diseases but a multitude of factors contributing at different levels. For instance, the relations between cells and diseases were progressively understood with many advances in microscopic histology in the nineteenth century, considering the variety of cells in the body and cells of external organisms entering the body. With Pasteur's germ theory (nineteenth century) a crucial door was opened for medicine to recognize external causes of the diseases and related physical reactions.

Medicine thus became able to see itself as not concerned with just one or a few explanatory models but instead opened up to a diversity of

elements in complex causal arrangements, contributing to the recognition of disease in an equally complex array of expressions, now revealed in intricate macro and micro interactions. Medicine also opened up to accept any breakthroughs that shook and changed previous assumptions. Breakthroughs became welcome; they were no longer seen as threats; trust of medicine firms' means of verification and validation encouraged openness for innovation.

Health as a function system was fully established in the fourth period. In the current stage of health as a social system it is possible to pinpoint a number of characteristics:

- Huge diversity of diagnostics tools and curative interventions;
- Long periods for training and developing professional competences;
- Differentiation of many specialities (not only in the medical field);
- Complex clinical laboratories;
- Complex development, manufacturing and administration of drugs;
- Complex use of technological tools and resources for diagnostics, treatment and post-treatment monitoring;
- Complex surgical procedures involving several specialists and complex equipment;
- Specificity of the semantics within each speciality;
- Wide-ranging advances in prevention strategies;
- Medicine of teams, covering distinct areas of expertise with specialized professionals working together for the same patients;
- Medicalization of life (from cradle to grave) with diverse range of age-specific preventive and curative interventions;
- Development of public health perspectives and multi-sector interventions addressing a wide range of health determinants;
- Projection of health as a global/planetary phenomenon requiring coordinated action among nations;
- Huge increases in costs and absorption of financial resources in healthcare provision, changing the general pattern from lots of needs/little to be done, characteristic of the preceding periods, to lots of needs/lots to be done/few resources, in correspondence

to what is known and what is actually possible to deliver given generalized resources constraints;
- Uneven distribution of the benefits of medical advances across countries and populations within countries.

System's features

Medicine of the health systems, as we may call the medicine that emerged in the twentieth century, has a comprehensive command of the complexities of the body, the expressions, causes and treatments of diseases. Medicine now exists within health systems that also acquired strong command of the complexities of a plethora of social organizations providing preventive and curative healthcare. The whole assemblage operates as a *social function system*.

We defend the thesis that in this fourth period medicine eventually lent its complexities and closure for the constitution of health as social systems. Obviously "lent" is a metaphorical expression. What we actually mean is that once medicine became exclusively medicine's own business, with its complex specific semantics and universal communication standards, a distinctive social function could be created and differentiated from all others.

With its self-reference established within that social space, medicine could then recognize and interact with several disciplines sharing health concerns, such as dentistry, pharmacology, nursing, physiotherapy, psychotherapy, bioengineering, nutritional science, which, in one way or another, adopted the same fundamental healthy/sick binary distinction. This large ensemble of knowledge and practices progressively developed a comprehensive all-inclusive self-reference as health social system, with wide concerns beyond the strict medical focus on diagnosing and treating individuals' diseases. We briefly recap this development in this section.

Medicine completed its emergence as a specific semantic universe of communications, offering solid anchorage for other disciplines dealing with health. The social recognition of medicine could thus be extended

to the disciplines with which medicine would share the same concerns, each covering distinct areas and complexities (such as dentistry) with which medicine would not be directly involved.

The disciplines dealing with specific health topics developed their own communications, but still remained within the boundaries of the all-inclusive health domain comprehended by the healthy/sick binary code. The progress of medicine was fundamental for that; without it the assemblage of related disciplines could not have evolved and accommodated the array of complex and diverse services that are now available in any health system.

Once operations and communications between doctors and other health professionals became a routine part of the processes of diagnosing and treating, the comprehensive structure (the health system) needed to be correspondingly acknowledged; recognized by itself and its components, as well as recognized by the society's systems at large.

Luhmann's (1998) theory claims that the constitution of a differentiated function system within a society structured according to functional differentiation is based on three systemic orientations: (1) in relation to the society (we add, where health is socially recognized as a distinct function); (2) in relation to other systems in the society for provision of inputs and outputs; and (3) in relation to its self-reflection as specific system.

The societies of the previous period identified medicine as having the purpose of knowing the body and doing something about the diseases. It existed mainly as part of an undeveloped science system, studying the body while providing commonly known treatments of doubtful efficacy. The prominent doctors in the history of medicine in those periods were scientists observing physical ailments. On the service provision side, in spite of the crowded hospitals of Paris in the eighteenth century for instance, medicine still had very little to offer, no different from in the previous periods.

However, the nineteenth century changed everything. Medicine could deploy a number of new therapeutics and therefore medicine's practices were recognized as having a broader scope beyond scientific research endeavours. The fight against charlatans begun in the eighteenth century was the affirmation that qualified doctors could pro-

vide a differentiated service, and that difference became increasingly marked as new therapeutic techniques were progressively developed and adopted, out of reach of charlatans. Service provision became distinctly marked and valued.

To the self-reference of medicine as scientific discipline, developing knowledge of the body and diseases, new competences expanded the social roles for providing healthcare, endowing medicine with a new outlook. The French Revolution brought the social role of healthcare provision to the fore. Although still lacking substantive therapeutic procedures at that time, the broader prospect and benefits of healthcare being incorporated into the politically enacted socio-policies became well understood and desirable. The notion of public health was born. Self-reflection for the health function system expressed not only attention to diseases but also the social distribution of risks of becoming sick and getting (or not) treatment.

The political mobilization of healthcare took place within the strengthened and legitimized space/function in line with the concerns of the political and legal systems. To deal with the new social configurations, meanings had to be created explaining what the new structures were intended to be.[6] The political relevance of having them in place was clear. This is how public health became a reality, first as a set of institutional meanings, politically established, legally recognized, to then operate as a field of communications, according to its own self-reference and self-reproduction.

The political system would not go beyond recognition of the health system, including medicine and public health, and would not run medical or public health businesses. These were exclusive competences of, respectively, medicine and public health. Health as a social system was thus established, with health becoming a function system within societies already structured with differentiated functional systems, such as the political, the legal, the scientific, the educational, the economic.

6 See discussion on the changes brought about by the French Revolution in the section on Foucault in Chapter 5.

Within the health social system, public health was the sub-system concerned with the health of populations. Public health was endowed with the corresponding mission to develop and explain the health system to the health system, defining its purpose and reason to exist, reflecting on health as a social phenomenon for which collective representation was needed, not limited to the medical focus on the individual patients. Public health thus became the way of explaining the health system to the political and legal systems, as medicine's language became too specific, within its exclusive focus on individual bodies, for communications outside the health system.

Medicine was not oblivious to the health of the collectives[7] and understood that diseases had common causes and occurred concurrently in many individuals. However, treatments were delivered to individual bodies. On the other hand, public health thinking aimed at what could be done at a social level; the social thus acquired prominence in public health semantics in contrast with its place in medical semantics. The two branches came to constitute the health system inclusive of all the other coexisting professional fields encompassing recognized health practices.

We can say that in this process medicine was strengthened. Within health as a social system, the medical nucleus obtained a recognized secure central position, in charge of identifying and treating diseases, and validating all meanings and understandings related to that. Medical knowledge could be debated, questioned, revisited, revised, modified, reworked and so on, with its achievements preserved.

Despite the fact that, in the very beginning, health systems were strongly reliant on decisions of the political and legal systems, progressively they became "sealed off" from external interference, though internally open for exclusive communications. It is good to remember that when we talk about closure we are talking about meanings, only about meanings. Closure is about communications and understanding

7 Epidemiology was accepted from its onset as part of social medicine, becoming recognized as a modern scientific health discipline with the works of John Snow on the cholera epidemic in nineteenth-century London.

of distinct meanings, within the limits the system considers meaningful for it. In this sense, "closure" is a technical term, a central concept in Luhmann's theory. Every time we use this term it carries the above-explained meanings in correspondence to the Social Systems Theory.

Towards the end of the nineteenth century, the health system had achieved its closure, becoming a function system differentiated from other function systems in the society, with its unquestioned exclusivity over the use of the medical semantics and validated health communications. The semantic territory was precisely marked.

The closure also implied self-regulation, as no other system or professionals could issue valid medical communications or judge the quality or validity of a medical communication. It also became valid for all non-medical professional fields operating within the health system.

To sum up our understanding of system's features in the fourth period, the health system, as the broader semantic space with medicine at its core, developed its self-reference. As a function system, the health system's self-reference narratives were constructed, portraying operations and achievements of the system as a whole.

Besides being the comprehensive domain of all that concerns medical practice, the self-image of a health system also incorporated public health indicators selected for that purpose. The narratives appear in plans, evaluations, policies, investment programmes, as well as epidemiological and demographic measurements, targets, reports and so on (Chapter 7 has an in-depth discussion of indicators).

The narratives reveal a health system addressing increasing complexities. The tension of the trade-offs between providing for the individuals and at the same time maximizing collective access to healthcare is an example of those complexities. The deepening of the distinct roles of the two subsystems (medicine and public health), expanding knowledge and practices in their respective semantic domains, with many internal semantic ramifications, is also a snapshot of the expansion of the system.

The tensions related to the ever-increasingly complex range of technologies and technical resources for diagnosing and treating diseases, and delivering them according to the model of comprehensive perma-

nent mandate by which everyone should be entitled to everything they need (universal health coverage) is in fact overwhelming.

Another feature of the health system's complexities is that it still requires individual doctors, although doctors now rarely work alone. More often they work in teams and require communications among specialists. They also rarely work without laboratory and pharmaceutical support, which have become an integral part of medical care. Consultations, although still seen as a relationship between the patient and their doctor, now requires a coordinated joint performance involving all the information gathered from laboratory tests and examinations as well as expert opinions from a diverse range of specialists. Routinely, in any medical setting, doctors consult their peers for matters within their specialities. This has become health system medicine. As the complexities suggest, healthcare is a multifaceted endeavour and only a system can deal with and deliver it.

While previously, in the former evolutionary stages, the uncertainties the individual doctors had to deal with were their own exclusive concern, now the concern belongs to the system. The system has to make sure that all doubts are dealt with in a systemic way; commissions need to be formed and informed, possible courses of action considered, possible evidence gathered before the system can make a decision, which will be the combined responsibility of the system as well as of the individual doctors.

Complexities

The discussions of systemic features of the period in the previous section have already portrayed the complexities of the fourth period. In this section therefore we have only a few more points to add.

As was already the case at the beginning of the fourth period, the full understanding of medical communications became virtually impossible for outsiders, and to a certain degree even for individual insiders. Hugely complex vocabulary denoting signs, symptoms, diseases, causes, conditions, treatments, and so on became a complex universe beyond the

competence of any individual professional, requiring multiple areas of expertise and connectivity between the semantics of several fields.

We may also say that in this last period the internal complexity of the system has become a crucial feature of the health system itself. While the complexity of the human body, uncovered in a series of successes in the descriptions of diseases and evidence of treatments (with knowledge by which many previously untreatable conditions are now regularly cured), the social organization of provision of healthcare to all who could benefit from the available knowledge was and still is highly problematic. The complexity of service provision thus affected the world of healthcare delivery in a system-wide fashion. Thus we can say that the complexity has now appeared inside the health system.

Obviously health systems' objectives have not been to cure all diseases in all individuals all the time. Human beings have to die at some point, and even in the best treatments, death is and will remain the unavoidable end point. But it has become clear that there are deaths that could have been avoided if the provision of care (including preventive care) was timely and sufficient. These problems mostly exist not because of the complexities and unknown facts about the body and the diseases but rather because the health system has not designed and set up arrangements and structures that could make the avoidance of those deaths possible.

As an example, if somebody dies in a road accident, that cannot be simply dismissed as an unavoidable death (as far as the health system is concerned), because if the person dies while being removed from the accident site in an ambulance not properly equipped with life-saving devices, that was then an avoidable death. What we call avoidable deaths are therefore those occurring because the health system was not optimally prepared to provide the curative or preventive services required (when the life-saving procedures are already known).

We may state that the complexity has become greater inside the health system than in the environment the system has to deal with. The system can show failures because of insufficient qualified professionals, lack of equipment and drugs, lack of organization, lack of correspon-

dence between its design and the needs, lack of resources, information, communications, and so on.

The complexities of the system emerge from the system's self-image as having to provide answers to all health needs, and the resulting dilemmas related to how to crack unsolvable problems of incompatibility of simultaneous solutions of equity, efficiency, responsiveness, efficacy, quality of care, and so on, in the present and the future. The system is therefore submerged in its own complexities, having at the same time to understand its limited horizons and reduce the complexities as feasible, often having to reject the optimal for the benefit of the possible. But the decisions to be taken are far from clear and simple.

Summary of medicine self-reference: fourth period

Self-reference of medicine in the fourth period is an integral part of the self-reference of the health social system. Medicine is identified and self-identifies as being a core element of health systems. It operates in conjunction with other elements comprising the system, making the health system an ensemble communicating with meanings referenced to sickness and treatments.

Nevertheless, during the almost two and a half centuries of the fourth period, medicine developed specific self-identifications, which progressively reflected on and were incorporated into the health system self-reference. These specific self-identity points are explained next.

- Medicine of the invisible – by invisible we mean the minuscule concrete as well as abstract objects or explanatory concepts. This includes cells (the works of Schleiden, Schwann and Virchow), germs (Pasteur, Koch and others, with the establishment of bacteriology as a medical discipline), genes and chromosomes (establishing medical genetics), molecules, the mind (psychiatry, psychoanalysis, psychotherapies), and imagery, radiation, statistical significance. Medicine of the invisible is also medicine of powerful tools such as drugs, radiation, biochemical reactions, equipment, laboratories, artificial intelligence, with new fields of observations, diagnosis and

therapeutics. As part of the medicine of the invisible, biochemistry, the action of drugs, and the close relation between pharmacology and physiology, became a universe of advances in itself. Each of the listed areas of advances has had huge impact in many medical fields; a very simple illustration is the knowledge of germs and the crucial innovations in asepsis and aseptic interventions.

- Medicine of specialities and sub-specialities: With multiple fields developing into areas of expertise with their own specific models and semantics, internal differentiation and categorization of medical fields has been a necessary complexity reduction strategy. Specialists can handle the complexities of their respective fields better than generalists. If kept undifferentiated, the joint complexity of multiple specialist fields becomes overwhelming. The potential for continuous increase and breaking down of new specialities exists, with narrower fields for in-depth observation revealing detailed components of the human body connected to specific diseases.
- Medicine of specialist teams: Compensating for the fragmentation into specialities, the medicine of the end of the fourth period has recognized itself as medicine of multidisciplinary teams working together. The teams bring diverse perspectives together, approaching singular cases with observations bridging specialists' fields. Often a specialist has to rely on teams of experts revising the literature to interpret findings not specifically within their speciality.
- Medicine of "information overdose": The spectacular increase in availability of medical studies through specialized publications (printed as well as online) corresponds to a huge explosion. Such explosion of information does require teams dedicated to searching through the available materials on any topic, making literature review a routine exercise in the practice of advanced medicine. Medical information has become popularized with easy access to publications online; the speed and volume of new works continuously published represents a big challenge to medical professionals willing to remain up to date on their specialities. On the other hand, the gap between non-professionals and professionals has become greater in spite of the ease of access to literature. The terminology used in

medical texts is highly technical and cannot entertain widespread understanding. The frequently defended idea that now patients are or can be as informed as doctors does not take proper account of the expertise required for correct understanding of what is written in the now accessible medical publications.

- Medicine of the collective:[8] The medicine of risk factors, numbers, statistical significance, hygiene, epidemiology, screening, surveys, surveillance, prevention, vaccination, clinical trials, environmental risks, sanitation, social determinants, and so on has its domains comprehensively included within the field of public health. With the notion of social factors, public health brought into its core the unfathomable complexities of more than two centuries of social science theories, with variables and research opening up countless avenues for analysing social determinants of diseases, treatments and deaths. Chadwick and Virchow (nineteenth century) were pioneers in linking poverty and diseases, and vice versa. Previously, although in ancient times the health of soldiers was a matter of concern, and prevention was imposed particularly during the Black Death pandemic in the fourteenth century, preventive measures became a serious technical matter requiring permanent attention in the third period. Thus, we can say that the orientation towards the collective and the social has been, if not latent, incipiently present in medicine since its start. But the advances of the last period in terms of the understanding of causes and methods for monitoring and tackling epidemics brought about major transformations, consolidating public health as crucial for ensuring the health of populations. In line with that, the understanding of the social distribution of health services in correspondence to the social distribution of risks of becoming ill and dying has relevance for the coupling of health systems with political systems. As noted in the previous sections, although originally indistinguishable from each other, public health became a

8 We use the term "medicine of the collective" in line with the orientation we have adopted in this book in correspondence to the emergence of public health as a distinct sub-system of the health system.

realm distinct from medicine, with both public health and medicine becoming sub-systems of the health systems.

- Global medicine: With the rise of international agencies focusing on health and the coordination among multiple international players, medicine and public health are now projected on a planetary scale. Heightened attention has brought diverse international players together to address regionally endemic diseases as well as epidemics and pandemics and access to quality healthcare. The global distribution of the burden of diseases with inventories of factors and consequences of global reach now more than ever includes the environmental impact of human activities.
- System's medicine: Self-reference, self-observation and self-reproduction are key functionalities of medicine and public health as core components of health systems. With increasingly demanding and complex orientations to prevent and treat all diseases, and to tackle all determinants of health, health systems are expected to demonstrate how they are going to go about delivering such ambitious aims. Health systems have fundamental attributes of self-reproduction carried out essentially through self-reference and self-observation; a health system, as constructor of its own references as a social function system, has to decide what it will continue doing, and what it will start anew. All decisions are observed and judged by internal as well as external observers. It is very hard, basically impossible, to satisfy everyone. But the health system, as a social system, above all needs to preserve its reproduction with the means it produces – that is, with its exclusive communications, which only the health system can reproduce.