Chapter 5
Causal Value and Causal Link

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Abstract After an overview of the evolution of concepts of truth, cause and causation in the history of philosophy, this chapter examines the current post-modern conception of material causality in the medico-legal doctrine, aimed at the identification of the core cause and the reconstruction of the causal nexus. The theory of the "conditio sine qua non" and the subsumption under scientific laws, which constitute the common denominator for the imputation of the event, are described in detail. The judicial inquiry and the expert's report, applicable in medico-legal practice of specific causality, are illustrated with particular reference to deductive-nomological and inductive-statistical models, as well as to the necessity of a new "evidentiary regime" for ascertaining professional medical liability.

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5.1 Principles of Truth and Cause

The *principles* of *truth, cause*, *causation* and *causal chains* are deeply rooted in the history of thought, in as much as expressive of the ontological need of man to give meaning to his existence. These principles evolved, in correlation with those of certainty and probability, from the naturalistic pre-Socratic school to the psychodynamic conception of SOCRATES, to the rational-idealistic speculation of PLATO, and to the rational-empirical-experimental, material, formal, and efficient conception of ARISTOTLE (Ferrara 2004; Ladyman 2007; Aristotle 1908, 2008). According to deductive or inductive criteria of certainty or probability of truth, the speculative evolution of causal principles has been influenced by neo-Platonic or neo-Aristotelian contributions, followed by those of the SCHOLASTICS, through the certainties of faith and reason of ST. THOMAS, from post-Renaissance Empiricism to "formal and categorical" Kantian rationality, before resulting in positivism and neo-positivism (Ferrara 2004).

In particular, in light of the Kantian vision (Kant 1781), causality is a category, such as space and time, applicable to reality, science, and other related disciplines, from medicine to history, ethics, and even politics. The concept of cause is the same in any sphere and dimension of life, and causality is, conversely and for whatever purpose, the means to ascertain the relationship between one event and another.

The inherent values of causation relate to *objectivity*, *regularity*, and *know ability*.

Reality is conceived as *objective* insofar as it exists independently of individual actions and subjective situations. Reality is such, furthermore, inasmuch as it is *regular*, where the existence of such conditions leads to similar effects in different times and places. Reality is ultimately *knowable* to the extent that the modalities of its occurrence are ascertainable. Even if things are not in themselves knowable, the mode of their way of appearing is, and in accordance with this Kantian axiom, NEWTON, and EINSTEIN search effectively for the modalities of appearance of reality (Dobbs 1994).

Nevertheless, the framing of the differences in attributions regarding causation is independent of and transcends the scientific context, up until ignoring and excluding it. Therefore, in accordance with HUME (1751) and REICHENBACH (1951), the cause may not be unequivocally proven in a scientific sense, but be the expression of coincidental occurrence and of a practical basis of explanation of reality, such as a reductionist, rather than holistic approach, where the cause involves the understanding of the totality of circumstances in which an event occurs (Mill 1868). Therefore, it is also the estimate of the *relative* contribution of each of the possible causal factors, or even the evaluation of the contribution of a specific factor to the totality of significant factors in the causation. So that, with a return to the Aristotelian vision of final causality, in the integral dimension of the teleological approach to the natural order of the Universe, the final search for the cause is the search for the first causes of nature. That is, the search for the *episteme*, capable of comprehending causation and identifying not only the phenomenon, but the reason for the occurrence of any event.

From these apparently contradictory assumptions derive concepts of truth and cause and the theories relating to "probability" as the basis of reality, as well as the prechosen system, precisely that of the postmodern society of risk (Cohen 1977).

In these, as highlighted by POPPER (1934), science does not advance through the progressive and continuous accumulation of truths that are gradually acquired through the testing of the hypotheses advanced by scientists (an ideal impossible to achieve for logical reasons), but thanks to attempts to refute the theories proposed. Scientific progress takes place because an error is discovered in a generally accepted theory, and thus the discovery of errors in existing theories obliges the scientist to abandon the previously considered hypothesis in order to propose a new one which is in accordance with all of the known facts (Ferrara 2004). Extremely distant, therefore, from the Manichean illusion of the Enlightenment of DESCARTES (1637) and the Scholastics of ST. THOMAS and AUGUSTINE, where good and evil, truth and error were clearly distinguishable and distinct (Ladyman 2007). Where the development of scientific understanding, as GRMEK (1998) noted, one of the greatest medical historians of the past century, was envisioned as "a staircase that rises triumphantly toward the temple of science, with each step representing a new level of scientific development, a truth reached, albeit partial, which should be considered definitive" (Ferrara 2004).

Contemporary epistemology has led to the subversion of the positivistic conception of technological and scientific progress, arriving at the conclusion that "science is nothing but a cemetery of errors" (Stella 2003). Fundamental, in this sense, are the contributions of KUHN (1970), in whose thought the idea of the foundation paradigm prevails, that is, of a formal science based on revolutionary discovery that creates a new paradigm; of LAKATOS (1968), for whom science is founded on research programs competing with one another and continually subject to methodological falsificationism; of LAUDAN (1996), for whom science and the research tradition are a set of general assumptions about the extent of processes, problems and theories of a domain of study; of CARNAP (1950), for whom the complete verification of a law is impossible even in the face of millions of positive examples; of FEYERABEND (Horgan 1993), for whom scientific progress is the result of continuous violations of mandatory principles and methods; and finally, of POPPER (1934), for whom nothing is certain in science, based on the triad of problems–theories–criticisms, and the only concrete possibility for the scientist is to hunt for errors (Ferrara 2004; Reichenbach 1951).

Science, therefore, anchored by the laws and paradigms equivalent to mere hypotheses, whose truth it will never be possible to ascertain, cannot offer any certainty (Blaiotta 2004). Almost as if to conclude a pluri-millennial historical cycle that restores value to "sophistry", a proponent of the inductive criterion of probability as synonymous with possibility and, therefore, uncertainty. Returning, with that, the value of *Art* to the science of risk, which medicine inevitably is as a matter of priority, called to govern the patchwork of differing sequences and *interconnected causes* or *contributing factors*, in particular the almost infinite variety of those factors which are *etiologic*, exogenous, endogenous, mono, poly, necessary, sufficient or insufficient, exhaustible or inexhaustible, static or dynamic,

genetic, anatomical and physiological, pathological, preexisting or contemporary or supervening, concurrent, exclusive, adverse or antinomic, known or unknown, *determining a pathogenesis*, *mono or multi-specific*, of a disease, symptomatic or asymptomatic, fatal or indifferent, known or unknown and, if known, predictable and/or preventable, controllable, or not, with etiological or symptomatic therapy (Ferrara 2004). All of this contributes to a Chaos, whose domain is based on descriptive data and methods (casuistry, statistical, logical-connective, formal) which show insurmountable limitations and exclusive reference to Criteria of possibility (Salmon 1992), and where probabilistic logicism is affirmed.

According to Jeffreys (1966), the unitariness of scientific knowledge is based exclusively, in fact, on elaborated and applied methods, rather than on the heterogeneity of acquirable data. Such unitariness is founded on the theory of induction, aimed at satisfying at least three logical conditions: the production of a general method; the abstraction from the world "in itself"; the use of postulates or rules that deduction cannot prove.

The rules, distinct from their empirical content, must in their turn: be applied to observational data; express themselves in a formally congruent manner with regard to each other; provide that the product of the inference may be erroneous, so as not to deny *a priori* the practical applicability of any empirical proposition.

In accordance with these principles, the principle of causality is defined as a "complex determinant" of the uniformity of nature, or as "similar antecedents able to produce similar consequences". The "antecedents", in differentiating themselves from the categories of time and space, exclude the utilization of chronological and topographical criteria in the identification of the cause and the reconstruction of the causal relationship.

The conjugation of inductive empiricism and probabilism, in assimilating the inference to the "degree of confidence" and "probability" (both "variables" according to observed or experimental cases), involves surpassing the historical limit of philosophical and scientific empiricism (Hacking 2001). All of this entails, therefore, the affirmation of the *principle of probability* as an *exclusive basis for the identification of the causative agent* and the *relationship of material causality*. As an extension of logic, including all of its principles, probability theory assumes the role of indisputable *interpreter of concrete reality*.

In contrast, and consistent with the above, the historical evolution of the principle of probability is explained by means of: *classical theory*, as demonstrated by the works of NEWTON, GAUSS and BOYLE (Anstey 2000; Dobbs 1994; Dunnington and Waldo 1955), and others; *frequentist theory*, of strong impact on the science of risk, from biomedicine to medicine and genetics; *logicistical theory*, adopted in the nonquantitative sciences, such as biology, sociology, psychology, economics, and theoretical informatics; *subjectivist theory*, characterized by reciprocal relationships with quantum mechanics and particle physics.

Despite the apparent multiplicity of the above theories, the concept and the principle of probability preserve unitariness in their practical applications, valid in order to provide solid ideological or computational support to diverse scientific disciplines.

5.2 Juridical Construction, Evidence, and Medicine

In the juridical framework some theories conceive the cause of an event as a necessary condition of the effect, while some view it as a sufficient condition among others. Regardless of the theory or vision adopted, the cause is a combination of factors to which one always owes an identical effect.

Human *responsibility*, correlating and linking causation to the law, offers its own close correlation and causation in the identification of natural events. Therefore, the definition of the effects of individual conduct necessitates the identification of the cause or the correlation of the reality before and after the explication of its conduct, methods, timing, and circumstances. Causation is an essential means to render the individual responsible for the modification of reality. Responsibility is a means and pragmatic value, useful for attributing and defining the history and consequential outcomes of individual actions, as well as for forming the identity and character of individuals. They are responsible as they intervene in reality, modifying it. Causation applies to individual responsibility, insofar as one is aware of the consequences that such a responsibility exerts on reality and on the life of single individualities (Mendelson 1998, 2000).

The holistic conception, or "judicial justice", finds in the judge the restoration of the right balance in the "bipolar relationship" of rights and entitlements which have been erroneously altered. It is a conception and holistic system where the identification of the material causes performs a classificatory function.

In *Law* the classification of a cause, as direct or indirect, determines the homologation of the cause of the action to the cause of the facts.

In *Medicine* the identification of efficient and precipitating causes is vital for the diagnosis and treatment of the imbalance and disease that derive from them.

In both disciplines the causal analysis is retrospective, from the current medical condition, or the legal context of the circumstances, to the origin or the act which has caused the transition, of the psychophysical or economic well-being, to the disease, disability, and final damage. In both disciplines, moreover, the cause of the pathological process, disability and/or damage must underlie the *Evidence* arising from observation and experience, classifiable on the basis of gradation levels. In the case of evidence based medicine (EBM), levels range from (1) the "Systematic Review of all reliant randomized controller trials", to (2) "At least one properly designed randomized controller trial" and "Cohort study, case control study", (3) "Historical controls", up to (4) "Case series" (Sackett 2000). The applicability of levels of evidence, the strength of the association between cause and disease and the accuracy in the estimation of risk must also underlie the careful evaluation of individual variability, the diverse implications of evidence obtained from other individuals and, therefore, the peculiarity of the individual and the specific circumstances, expressed by genetic predisposition, gender, age, comorbidity, drug use, degree of exposure, mode of survey and identification of the disease. The manifold variability in the level of scientific information on causation, never static but always and more frequently subject to frenetic

evolution, is influenced today not only by genetics, but rather by systems biology, that is, by genomics, transcriptomics, interactomics, proteomics, metabolomics, and so on.

The tumultuous evolution of scientific knowledge, in comparison with the pragmatic view of the judicial system and of the parties to the proceedings, brings up the problem of selection, qualification and the roles of the *expert witnesses*. In particular, it suggests the need for the impartiality of the expert witness, to be anchored to scientific and technical data, independent of the interests of the individual parties. That is, in the defense and representation of science, rather than of the parties involved in the proceedings. All of this is achieved through the careful evaluation of the scientific quality of the evidence produced, in the clear differentiation between fact and opinion, in addition to the *intellectual honesty to claim causal uncertainty when the cause is unknown*, *due to lack and/or non-reliability of the data* or for *inadequate application and/or knowledge of statistical probability*. And, therefore, with recognition of the continued validity of the assumptions of Roman law regarding causation and fault, not deeming the latter sufficient for the assertion of responsibility, especially in the field of malpractice and medical liability. This is equivalent to affirming, even in the contemporary era, the validity of the assumption to avoid, on the subject of medical causation, reductionist or one-dimensional approaches. This, again, is equivalent to saying that the multidimensional and epistemologically impure nature of causation put forward in court involves extensive sharing, both in legislative-juridical evolution and in the development of social and private insurance regulations.

Also in light of the foregoing, there is a meeting, a *confrontation between biomedical science and law*, dominated by the erratic chaos of uncertainty and error, the second necessitating certainty, which is essential for the attribution of the damaging event, the identification of the offender and the reconstruction of the material causal nexus between conduct and event, including a degree of conviction of the judge *beyond any reasonable doubt*. This in order to guarantee and protect victims, the innocent, safeguard inviolable individual and collective rights, good name, reputation, freedom (as understood in its broadest sense) and the values transcending and founding the most advanced democratic societies. Societies in which the cause is a necessary condition, and in which recourse is wisely made to a legal construction of scientific knowledge.

Since no agreement exists between philosophers of science on a single scientific method, and as the current methodology proposes diverse and contrasting research methods, the need to ensure the highest degree of certainty has imposed the enunciation of a clear legal rule: the court must only take into consideration reliable *scientific hypotheses that have received the degree of confirmation required by the inductive* conception of the scientific method and, furthermore, which conform to the requirements set out by *the falsificationist conception*, possibly supplemented by the criterion of general consent. What is important, given that there are no certainties in science, is strict adherence to the scientific method. The judge will need to decide on the question of the reliability of the scientific hypothesis relevant to the process, making sure not only that hypothesis

has received confirmations from various empirical checks, but also that it has withstood the necessary attempts at falsification.

A juridical construction of science, therefore, in which scientific knowledge by hypothesis, contingently true, acquires validity according to the specific aim pursued, and in which, for the Sciences of risk (including bio-medical), the general and/or specific (individualizing) causality is confirmed or denied, depending on the error rate and probability. Being able to recognize the value of truth (thus far resistant to falsificationist confirmation) *only* at the beginning of the causal chain based, *exclusively and uniquely*, on the confirmed corpuscularian and quantum–mechanical theory (Freckelton 2002).

This conclusion, exposing the fragility of certainty of knowledge, reaffirms the, albeit noble nature of the *Medical Art*, rather than that of science, imbued with the hyper-technological contents of the post-modern era. Thereby recognizing the value of juridical knowledge, whose principles and models on the subject of causality are certainly more of a guarantee for the protection of the individual and collective primary goods, inasmuch as culminating in the rule of *Beyond any reasonable doubt*, often obsolete in the ranks of the Sciences of risk, to which belong medical art and any of its specialist use of adjectives, including those of legal medicine. In reality, thereby having to confirm that the nosographic classifications, the etiopathogenesis and physiopathological interpretations, the diagnoses, prognoses and treatments, the evaluative epicrises, belong to a system of knowledge whose reliability, truth, or falsity depend on the transient systematic theory and practice of the Bio-Medicine of the time, the progress of which lies in the discovery of errors and the development of new theories. With this, fully confirming the Hippocratic Oath of the third millennium which, *in founding the ethical role of the doctor's professionalism* across cultures and social contexts, recognizes the aforesaid assumptions and states that the new contract of the *Doctor*, stipulated with the individual-patient and with society, must be based on the assumption of a new role, that of the *Researcher*, *constantly in pursuit of Errors*, the discovery of which reduces the uncertainty of science, enhances professional formation and improves the "Quality System" (Ferrara 2004, Ferrara and Pfeiffer 2010).

5.3 "Conditio Sine Qua Non" and Scientific Laws

The *conditio sine qua non* or *but-for cause*, theory of universal use, constitutes everywhere the *indispensible minimum* for the objective allocation of individual harmful events. So it is, in effect, in European Criminal Justice Systems, starting with Germany, where the equivalence theory of causes is now accepted as the first and essential criterion for criminal charges and where it is assumed that any other causal theory (such as that of *adequate causality*) or objective criteria of importance (i.e., *the increase of risk*), requires as an indispensible minimum the subsistence of a

condition that can withstand counterfactual reasoning, namely that it can not be eliminated mentally without the elimination of the event (Freckelton 2002).

In the same situation as Germany one finds, just to cite some of the European Countries, the United Kingdom, France, Spain, and Italy. In the UK, in fact, the use of the *but-for cause* is generally accepted, both in doctrine and in case law, in line with the approach of all or nothing, which is typical and traditional in *common law*. Even in France and Spain it is accepted that the *conditio sine qua non* constitutes the basis for criminal charges for damaging events, recognizing also the postulate of equivalence of conditions. For Spanish criminal lawyers the triumph of the conditionalistic theory played down the significance of the causal problem, at least in the field of criminal law. The existence of causality continues, in fact, to be a requirement in all criminal offenses: in crimes of endangerment, because it is necessary that the author has caused the risk, as in a harmful offence, since these presuppose that the offender caused impairment of the legal right of the victim, the proof being insufficient that the conduct has created a risk (Barni 1995). Thus, also in the Italian legal system, where material causality has its normative foundations in the Criminal Code, (art. 40–41) based on the theory of the necessary condition, also known as the equivalence of causes, supported by the theory of scientific laws of coverage and tempered by so-called causal regularity.

Even in the system of adequate causality the *conditio sine qua non* remains the essential prerequisite, built on the following principles:

1. the event must be a consequence of the conduct and the behavior is considered to be the cause only when it constitutes a necessary condition for the event;
2. the behavior of a man can only be one among many necessary conditions of the event so that, from a logical point of view, the cause must be understood as a totality of necessary conditions, not as a sufficient condition, and from the point of view of criminal law, the cause does not coincide with the "sufficient" condition, but with the "necessary condition";
3. the human conduct is never a necessary condition in absolute terms, but it is in contingent terms, or rather in a specific context of concrete conditions; since it is not possible to grade the effectiveness of every single condition, all those indispensable to the occurrence of the event are considered equivalent to each other and equally causal, i.e., with the same legal significance;
4. the demonstration of the causal nexus, being a posteriori or *ex-post*, aims to determine whether human conduct has been a contingently necessary condition for the occurrence of the event;
5. the criterion of the adequacy of the cause—that is, of adequate randomness—operates in addition to and not as a substitute for the conditioning nexus;
6. the counterfactual reasoning is indispensable in order to establish whether particular human conduct is actually a necessary condition for the occurrence of the event, and to proceed to the mental elimination of such a condition, verifying, always mentally, if the event would have happened anyway.

5.4 From the Theory to the Practice of Specific Causality

The above mentioned theories find logical-conceptual support and corroboration in the *scientific laws of coverage*, in *universal scientific laws or statistical laws*, able to prove with certainty or various degrees of probability that a particular condition is invariably followed by the verification of a specified event. Although belonging to the category of scientific laws, the statistical laws provide propositions and offer causal links only in terms of probability, not certainty, meaning that a particular event is accompanied by another event only in a certain percentage of cases, with the consequence that such laws are much more equipped with scientific validity, inasmuch as they can find application in a high enough number of cases receiving confirmation from rational and controlled testing methods (Barnes 1983).

It is universally accepted in medical legal doctrine that the subsumption under scientific laws of coverage is applicable both in terms of causality by commission or omission. In both areas, the logical procedure utilized for the causal reconstruction makes use of two fundamental explanatory models:

- the *deductive-nomological* model, in which the *explanandum* is derived through a deductively valid reasoning from the *explanans*;
- the *statistical-inductive* model, in which the *explanandum* possesses a high inductive probability with regard to the *explanans*.

The assessment based on the *deductive-nomological* model employs *universal laws* and permits deductive conclusions and, therefore, theoretically substantial *certainty*. The preliminary criterion, which should always be applied, is that of the so-called *scientific possibility* of a *causal nexus*, also defined as (ex-ante) *capability of causing harm.*

The medico-legal expert, who is called upon to decide on the possible existence of a causal nexus between conduct and material damage, in the absence of scientific laws of universal coverage, will often be forced to resort to the use of statistical laws, pointing out, however, that the demonstration of the nexus with a criterion of high probability-near certainty will be possible only where there is a high degree of logical probability or rational credibility (Cohen 1977). In other words, one will be able to hold that the conduct of the agent constitutes a necessary condition of the event, only if, without the agent's behavior, with a high grade of logical probability, it would not have occurred; or rather, when it is possible, with any reasonableness and rational justification, to exclude the involvement of a different causal process (i.e., "counterfactual reasoning"). This model is applicable to cases which involve commissive conduct, where there is clear and convincing evidence of the applicability of the general laws of physics, chemistry, and biochemistry, physiology and knowledge of general pathology. Knowledge that can well be regarded in the same manner as universal laws (Ferrara et al. 2010; Ferrara and Pfeiffer 2010).

The logical process of assessment by the *inductive-statistical probabilistic model* is based on the use of statistical laws or maxims of experience that,

integrated with each other, enable a probability of a causal nexus to be inferred, almost always in terms of prevalence, which is difficult to quantify on the hypothesis of improbability. This model is very often applied in the biomedical-legal field and concerns, in particular, cases of ommissive conduct typical of professional medical liability, environmental damage and damage to the product.

The inductive-statistical explanatory model can also benefit from the application of additional and indicative medico-legal criteria of evaluation regarding the causal relationship. They are criteria that, if utilized appropriately and critically, still represent a useful applicative tool in the logical-probabilistic-inductive procedure. In the doctrine, these criteria (topographical, chronological, phenomenological continuity and exclusion of other causes) are frequently listed without a hierarchical order and in varying numbers, while it is appropriate to use them in an articulated manner, as a guide for the organization of a case study. If the current scientific knowledge of the data of the specific case makes the accreditation of a causal link impossible from the outset, the assessment should be interrupted. Only two conclusions are possible: the exclusion of the nexus or the impossibility of its ascertainment (Barni 1995).

The first and most important criterion, which is that of *harmful efficiency* or *capability of causing harm*, refers to a nomological paradigm, while the other criteria require concrete proof in order to demonstrate the appropriateness of the scientific law. Among the criteria described above, the exclusion of other causes deserves particular emphasis, being fundamental and, in general, more complex than the others, as it is potentially a harbinger of misconceptions, since it is involved both in the process of identification of the entire causal chain, necessary and sufficient, and in the assessment of the necessity of the individual causal conditions of all the etiological factors. This fundamental medicolegal criterion corresponds to the differential diagnosis in medicine, in which the hypothesis that survives among the various hypotheses put forward, through the procedure known as "MODUS TOLLENS", requires, in its turn, the search for evidence in its favor, making use of an inductive approach of an eliminative type (Blaiotta 2004).

The use of customary and well-established medicolegal criteriology must, in the final analysis, be directed toward the reconstruction of the intermediate causal links, with the aim of giving concrete form to the scientific laws of coverage in the specific case, in a transition from the ambit of general causality to that of individual or specific causality. It involves, therefore, an accurate search for evidence that allows the reconstruction of the complex *causal puzzle* and the necessary transition from factorial adequacy to (almost) causal certainty. The cause, conserving and accentuating its epistemological contractions, cannot but distinguish itself as the basis of a medicolegal judgment founded on the evidence (Stella 2003).

In order to identify with high probability the existence of a material causal nexus, the demonstration of damage eligibility *ex-ante* is not sufficient, which is an error that, unfortunately, many of the various bio-medicolegal and/or forensic "experts" still commit. It is a sort of inherent flaw that has considered the concept of cause in an autonomous way, detached from the point of view of the law and therefore from the concept of a necessary condition, replacing it with the concept

of *capability of causing harm*, or rather, "adequate causality". It is an adequate causality which is wholly foreign to the world of biomedicine and legal medicine. The criterion of eligibility or causal adequacy is certainly not sufficient, but rather a prerequisite, for the medico-legal opinion on the existence of a causal link between the event and the damage, which is equipped with high probability-near certainty. Clearly, there is a strong need to find the particularistic evidence of the nexus, seeking a mechanistic explanation by means of chains of cause and effect, in which individual events are explained in a deterministic sense.

In the absence of a transition from the general causality to the specific causality, the model of subsumption under the laws of science would remain a hollow expression: the failure to verify the concrete antecedents, including the concrete *but for* antecedent, subsumable under the abstract antecedents, provided by the law of coverage, render vain any reconstructive attempt. In other words, there is a need to formulate an *ex-post judgement* linked to particularistic evidence of concrete expression, and not based on bare statistics.

Still more difficult is the problem of the reconstruction of the causal relationship in the ambit of *omissive causation*, where the finding of real and objective data, which permit the reconstruction of the causal intermediate links, is extremely rare and the reconstruction is largely based on hypothetical and/or prognostic judgments which, supposing the dutiful act has been carried out, ask whether the harmful event would have occurred anyway. In order to recognize the causal nexus, even in the field of omission it is necessary to achieve the highest possible degree of probability, thereby finding that the dutiful act, if accomplished, would have been able to prevent the event with a probability close to certainty (Stella 2003).

In the medical-surgical area, and specifically in professional *medical*-healthcare *liability*, the problem of omissive causality reaches the highest vertices of complexity, since the maximum part of the explanations offered is based on probabilistic laws with a low coefficient, which are not capable of providing mechanistic explanations. Therefore, when assessing by counterfactual reasoning what the consequences of the correct alternative medical conduct, omitted by the attending physician, would have been, the degree of probability by which to assess the effects on the health of the patient are not to be referred to mere statistical probability derived from previous trials, but the concept of logical probability, which must be close to certainty. The logical probability, in its turn, must be constructed by epicritically assessing all the circumstances of the specific case as they appear from the collected evidence (Stella 2003; Barni 1995).

Consistent with the principles of probability the conclusions are equivalent to the assessment of the degree of probability, the expert being unable to express opinions that would compel the judge to make a decision, which is only assumable on the basis of the whole spectrum of information derived from the various sources of evidence. Applying probabilistic logicism, where the production of evidence is based on experimental or observational data, the expert interpretation must be founded on principles and expressions of probability, rather than on descriptive adjectives. In the unfolding of the production of proof the acceptability and the utility of scientific evidence assume great importance in the trial, where the

qualification, experience and competence of the expert, as well as the "peer-review" of the opinions expressed by other experts, acquire relevance.

More specifically, in relation to the criteria of procedural *acceptability* of scientific evidence, the selection of scientific concepts and methods must arise from the consensus of the scientific community as to the limits of the demonstrability of the assumptions and the evidential value of the methods and conclusions. In order to clarify in the context of the individual case the probabilistic value of the observational or experimental evidence. In line with the process of preordained validation of scientific evidence through "standards of acceptability" previously established on the basis of "consensus documents", or derived, rather, from judgments of significant innovatory impact (Daubert v. Merrel Dow Fharmaceutical, Inc., 113 S. Ct. 2786–1993), thereby rejecting the principle, sometimes widespread in the judicial contexts of some countries, of the proclaimed "legal and judicial autonomy" of the validation of the acceptability of scientific methods and conclusions.

The application of probabilistic logicism, the sharing of criteria of *admissibility* and the unanimous acceptance of methods and results of scientific evidence all find common ground in margins of uncertainty, intrinsic structure, means of production, and the interpretation of the same results. All of these are subject to possible dispute and balanced debate between the parties, for which the identification of causality is the expression of degrees of probability.

It is implicit, however, that the *quality of evidence* must be supported by the degree of general and specific reliability of its production, by means of verifying: (1) the assertive effectiveness of scientific data; (2) the diversification of evidence; (3) the conformity or discrepancy of knowledge arising from evidence; (4) the availability of alternative tests capable of modifying the judgment already acquired. From the entirety of the means of production, eligibility and acceptability of the methods and acquirable outcomes in the form of scientific evidence, there emerges indicative guidance on the explication of best conduct on the part of the Judge and the Expert.

It is advisable for the *Judge* to keep in mind that: (1) the truth can not always arise from a single piece of evidence or a grouping of evidence; (2) uncertainty is desirable; (3) the evaluation of the context "a priori" and the proof must be founded on the rules of probabilistic logicism; (4) the weight and individual quality of each piece of evidence must be evaluated separately from the general context; the decision, never relying on a single piece of evidence (to which it would remain hostage), must be the expression of multiple reciprocally independent scientific findings; (5) the quality of the evidence provided by the Expert should be subject to verification in itself and in the general evidential context (Pascali 2011).

There are a number of key elements that it is advisable for the *Expert* to keep in mind: (a) to prove the hypothesis and not absolute truth; (b) to ignore the procedural evidence of nonscientific value; (c) to disregard the nature of the proceedings, be they penal or civil, as well as the party (prosecution or defense) for whom one is working; (d) to express numerical evaluations of the value of

evidence according to scales of shared measurement; (e) to search for and assess multiple evidence, ensuring reciprocity and independence; (f) to provide, on an exclusive basis, evaluations and opinions that correspond to one's proven expertise; (g) to show any discordance in the resulting evidence; and (h) to admit the objective impossibility or incapacity to provide evidence in the context of a specific case (Pascali 2011).

In spite of the trust that the public places in the scientific process, there exist many objections to the quality of evidence adduced by forensic scientists and the validity of the above guidance of probabilistic logicism. It would therefore be particularly necessary that a *new evidentiary regime* permeate the scientific evidence produced during the trial, beginning with greater uniformity between national or continental judicial systems, and in particular between "North America and Europe", where, in the latter, the activity of the forensic expert is often the expression of an autonomous profession. Often there is, in fact, diversity in conceiving expert testimony and practicing rigorousness in the methods and the standards of evidence. It concerns limits which are particularly relevant in the category of medical expertise, where the ascertainment of material causality is focused on the demonstration of the cause-effect relationship between harmful means, injury and/or death. The medical examination of the living or deceased person, in creating a collection of data, is equivalent to the obtainment of recorded rather than experiential evidence, thereby proposing a clear separation between circumstantial and medico-technical evidence as a fundamental paradigm of any inference. The Expert should reason, therefore, only on the basis of medical data, leaving to others the logical combination amongst these and other data which are not pertinent to the medical field; avoiding the commingling of plans and consequent inferential confusion, for which it is easy to commit abuses of logic with significant consequences concerning the acceptability and admissibility of scientific evidence.

The process of formation of medical evidence finds obvious and particular significance in the category of cases of professional "medical liability", where much of the non-empirical evidence is derived from the interpretation of health records. There subsists, in fact, a profound difference between the neo-production of a test (of genetic fingerprinting, toxicology, molecular-biology, etc.) and the utilization of evidence from previous clinical, instrumental, laboratory results, etc. In identifying the cause there exists a profound difference between the phenomenic explanation, through the interventionist criterion or through the descriptive criterion of pre-existing evidence. The experimental evidence is, in fact, aimed at satisfying the requirements of inference. The evidence arising from past unselected data, insofar as produced by others (but inferable, for example, from health records), is foreign to the direct satisfaction of inferential purposes, with the result that the interpretations of preexisting medical data can be characterized by a high degree of potential ambiguity and are therefore difficult to classify, with consequent extraneity to the experimental acquisition of evidence, on which the probabilistic logicism must be based. From such a limit, as well as from the difference of subjective interpretations and the frequent lack of rigor in the logical inference

of the clinical-therapeutic ascertainment methodology, there arise difficulties, delays and disagreements in the expert evaluations and opinions on the subject of alleged medical professional liability, which can be remedied only through the application of rigorous, shared and widely applied guidelines regarding ascertainment methodology and criteria of evaluation.

References

Anstey P (2000) The philosophy of Robert Boyle. Routlege, London
Aristotle (1908) Nichomachean ethics. Clarendon Press, Oxford
Aristotle (2008) Physics. Oxford University Press, Oxford
Barnes DW (1983) Statistics as proof. Little, Brown, Boston
Barni M (1995) Il rapporto di causalità materiale in medicina legale. Giuffrè, Milano
Blaiotta R (2004) La causalità nella responsabilità professionale. Tra teoria e prassi. Giuffrè, Milano
Carnap R (1950) Logical foundation of probability. University of Chicago Press, Chicago
Cohen JL (1977) The probable and the provable. Oxford/Clarendon Press, Oxford
Descartes R (2007) (1637) Discorso sul metodo per dirigere la propria ragione e cercare la verità nelle scienze. Siena, Barbera
Dobbs BJ (1994) Newton as final cause and first mover. Isis 85(4):633–643
Dunnington G, Waldo P (1955) Carl Friederich Gauss: titan of science. Hafner Publishing Co., New York
Ferrara SD (2004) Arte medico-legale. Unitarietà di sapere e qualità di sistema. Riv It Med Leg 26:273
Ferrara SD, Pfeiffer H (2010) Unitariness, evidence and quality in bio-medicolegal sciences. Int J Legal Med 124(4):343–344
Ferrara SD, Bajanowski T, Cecchi R, Snenghi R, Case C, Viel G (2010) Bio-medicolegal guidelines and protocols: survey and future perspectives in Europe. Int J Legal Med 124(4):345–350
Freckelton I, Mendelson D (2002) Causation in law and medicine. Ashgate/Dartmouth, Aldershot/Burlington
Grmek MD (1998) Western medical thought from antiquity to the middle ages. Harward University Press, Cambridge
Hacking I (2001) An introduction to probability and inductive logic. Cambridge University Press, Cambridge
Horgan J (1993) Paul Karl Feyerabend: the worst enemy of science. Sci Am 268(5):36–37
Hume D (1751) An inquiry concerning human understanding. Cambridge University Press, Cambridge
Jeffreys H (1966) Theory of probability. Clarendon Press, Oxford
Kant I (1781) Critique of Pure Reason. Cambridge University Press, Cambridge
Khun T (1970) The structure of scientific revolutions. University of Chicago Press, Chicago
Ladyman J (2007) Filosofia della scienza, Tommaso Piazza Carocci, Roma
Lakatos I (1968) Criticism and the methodology of scientific research programmes. Proc Aristotelian Soc 69:149–186
Laudan L (1996) Beyond positivism and relativism: theory, method, and evidence. Westview Press, Boulder
Mendelson D (1998) The interfaces of medicine and law: the history of the liability for negligently caused psychiatric injury (nervous shock), Dartmouth, Ashgate, Aldershof/ Burlington
Mendelson D (2000) Torts. Butterworths, Sydney

Mill IS (1868) A system of logic ratiocinative and inductive. Lightning Source UK Ltd
Pascali V (2011) Causalità ed inferenza nel diritto e nella prassi giuridica. Giuffrè, Milano
Popper K (1934) Logica della scoperta scientifica. Einaudi, Torino
Reichenbach H (1951) The rise of scientific philosophy. University of California Press, Berkeley
Sackett DL, Strauss SE, Richardson US, Rosenberg W, Haynes RB (2000) Evidence-based medicine how to practice and teach. Churchill Livingstone, London
Salmon W (1992) 40 anni di spiegazione scientifica. Scienza e filosofia 1948–1987, Muzzio, Padova
Stella F (2003) Giustizia e modernità. Giuffrè, Milano