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La Sicurezza in Ospedale: dalla tradizione all'innovazione.

Elaborazione di un piano di intervento multimodale per la riduzione
del rischio infezioni nosocomiali

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Background

Healthcare in Italy occupies more than 7% of the Gross National Product (GDP) and on average represents about 80% of regional budgets. These two simple data, in a context of evident progres-sion of population aging, are sufficient to reliably estimate the development of the health sector in socio-economic terms. In recent years, Italian health and welfare services have been increasingly in-terested in improving the quality of their services and this interest is dictated on the one hand by the need to make available services that are more adequate to the growing expectations of the popula-tion, and on the other by the need to reduce costs, thus increasing efficiency, in order to contain the explosive growth trend of national health expenditure. In this scenario, healthcare organizations and companies producing related goods and services must ensure effectiveness, efficiency and quality to protect health and equity of access to services. Although it is possible to measure and improve health care performance through the use of appropriate, often non-point indicators, such health care performance has inherent variability related to factors that cannot be changed or predicted. For ex-ample, the human factor, which is fundamental to the delivery of health services, is affected by the possibility of the occurrence of errors or uncontrollable adverse events, such as care-related infec-tions.

However, there is a specific risk, for patients as such, that can be linked to errors or adverse effects of clinical-assistance activities, configured in the definition of an adverse event, in addition to care-related infections. This term combines as a risk situation the unpredictable biological reactions of pa-tients with reactions caused by human failures or those of the system in which care is provided.

Therefore, the culture of applying, even in medicine, safety models developed in contexts based on the principle that error, even when it is directly human, is attributable to shortcomings in the organi-zational system in which operational processes are developed and which use proactive rather than reactive processes, is spreading.

The statement "to err is human" is increasingly being used to emphasize and characterize the inter-ventions to be implemented, which must be essentially structural and systemic, allowing the respon-sibility of the individual operator to be eliminated. Unfortunately, Murphy's Law must also be taken into account and, therefore, it must not be forgotten that if an adverse event can occur, there is a high possibility that it will happen and, therefore, it is necessary to adopt techniques and methods of Clinical Risk Management capable of preventing and eliminating any possibility of error materializ-ing. The methods known and used up to now do not have the capacity to give us this guarantee of efficacy, but if used appropriately they have shown themselves capable of significantly reducing the number of errors in healthcare. Any healthcare organization that focuses primarily on effectiveness through a quality-driven approach must make optimal use of a risk management program.

Upstream of any "definitive" approach to managing and eliminating errors in the ward, there must always be a system of analysis and verification of the context of the healthcare situation under ex-amination. Therefore, a fundamental role is played by the presence of an "Incident Reporting" method within the healthcare structure that can highlight the most critical areas and those most in need of management intervention. Even managing risk, unfortunately, has a cost and knowing and planning an intervention must be supported by data of real need in order to rationalize spending.

From the analysis of the events and near-events occurred in the various departments it is necessary to intervene using the method that is most suitable and essentially based on two management sys-tems: reactive and proactive.

Reactive management is based on the analysis of events that have already taken place, studying the chain of triggering factors in order to take corrective action if possible. One of the most widely used tools for this purpose is the "Root Cause Analysis" which is based on the principle of a detailed de-scription of the events that led to the accident, made backwards, so as to retrace the causal chain. This method is flanked by the reporting and analysis of the so-called "almost events" or "near miss-es", i.e. those cases that only by chance did not cause damage.

Proactive management, on the other hand, is based on the foundation of identifying possible areas of risk in order to intervene before they can give rise to negative effects. This method is clearly more effective in preventing adverse events, but at the same time requires a considerable implementation of the entire organization of risk management: it requires knowledge and awareness of the problem by health workers, an adequate data collection system, the establishment of specific work teams with the sharing of the analysis, implementation of well-defined procedures for the study of causes, areas of intervention designed and implemented through systems of continuous verification. Some examples of such methods are: FTA (Fault Tree Analysis), ETA (Event Tree Analysis), Fmea (Fail-ure Mode and Effect Analysis). In addition to the latter, the IFT/FMECA (Integrated Fault Tree/Failure Mode Effects and Criticality Analysis) method must be added.

Another important aspect to reduce clinical risk is the proper management of hospital hygiene aimed at controlling and reducing nosocomial infections, as these are an important public health problem in terms of mortality and increased costs. Nosocomial infection is defined as an infection that devel-ops during hospitalization and is not present or incubating at the time of entry into the hospital, while for health care personnel, an infection contracted due to care or laboratory activities is defined as occupational nosocomial. In Italy, on the basis of data from SDOs (Hospital Discharge Cards) it can be estimated that each year 450,000-900,000 nosocomial infections occur. Of these, 30% are potentially preventable and therefore it can also be estimated that 135,000-270,000 preventable in-fections occur each year.

In addition to being frequent, hospital-acquired infections are also serious: this is particularly true of sepsis and pneumonia, with mortality rates of 20-30%; overall, 1% of patients who contract an in-fection subsequently die as a direct effect of the onset of infection, while in 3% of cases the infec-tion actively contributes to death, although it is not the sole cause of death.

A recent report analyzed findings from the published medical and economic literature to provide an estimate of the annual direct hospital cost of treating nosocomial infections in the United States. The total annual direct medical costs of hospital infections for U.S. hospitals range from $28.4 bil-lion to $45 billion. After adjusting for the range of effectiveness of possible infection control inter-ventions, the benefits of prevention range from a low of $5.7 billion to a high of $31.5 billion (70% of preventable infections).

Without, however, forgetting that a key element in the fight against nosocomial infections is the prescriptive appropriateness of antibiotic therapies in order to reduce the selective pressure that fa-vors the emergence of resistant strains. In this scenario, programs for the

proper management of an-tibiotic therapies, the so-called antimicrobial stewardship, represent an essential tool. In several Eu-ropean countries, antibiotic prescription control systems have been in place for some time, requiring the collaboration of specialists such as clinical microbiologists and infectivologists. The role of the infectious diseases specialist in improving therapeutic appropriateness is well established in the sci-entific literature, with positive effects on patients' outcome and on the reduction of nosocomial in-fections, thus ultimately reducing antibiotic resistance rates and their associated direct and indirect costs.

Thanks, for example, to the evaluation of epidemiological data collected in our region through the Si.Re.Ar. network, some peculiarities of the antibiotic resistance phenomenon have been highlight-ed, with several trends that are of great concern such as: resistance of Enterobacteriaceae to third-generation cephalosporins, fluoroquinolones and aminoglycosides; resistance to carbapenems of K. pneumoniae; combined resistances of multi-resistant strains of P. aeruginosa, A. baumannii, and K. pneumoniae; levels of methicillin resistance expressed by S. aureus; prevalence of enterococci re-sistant to high-concentration aminoglycosides; and levels of S. pneumoniae resistance to macrolides and penicillin.

The early diagnosis of infections sustained by multi-resistant germs is an indispensable tool that can be used to contain their spread within the hospital, thanks to the prompt application of management protocols of control and to establish a timely and appropriate antibiotic therapy that is associated with a significant reduction in mortality rates.

In the last year, the international health system has been involved in a very serious emergency and has introduced several protocols to prevent the spread of the disease due to Sars-CoV-2. In fact, with regard to environmental contamination, a potential mode of indirect contagion, evidence from previous studies on coronaviruses shows that this particular group is more stable in the environment than other enveloped viruses. Transmission of SARS-CoV-2 occurs primarily by two modes: through large respiratory particles (droplets >5 μm) and by contact, either direct or indirect. Other routes of transmission have also been proposed, such as airborne transmission via aerosols (particles <5 μm) and transmission linked to fecal excretion, but these have not yet been fully elucidated. It was necessary to implement all the essential measures to limit the environmental transmission of the virus and to adopt all the necessary contact precautions: limit exposure, properly sanitize hands, properly use medical devices and PPE, sanitize surfaces and environments. Indoor environments, where people spend most of their time, consist of a specific microbial community, called the indoor microbiome. Most indoor environments are connected to the natural environment through high ven-tilation, but some environments are more confined: hospitals, especially intensive care units and op-erating rooms are "special areas" of living and working for humans. The purposes for which con-finement is practiced are different: a patient must be protected because he/she may be more vulner-able to infections from the external environment, so these confined environments must be sanitized and disinfected (cleaning and disinfection) with specific procedures aimed at minimizing the micro-bial load, to avoid the spread of nosocomial infections. The risk of becoming infected is increased when invasive but clinically necessary procedures are practiced (such as catheter insertion), but also due to the architectural design of hospital environments (such as ventilation systems), or due to in-adequate sanitation procedures. For example, a significantly higher risk of infection with antibiotic-resistant microorganisms

was observed when newly arrived patients were placed in rooms previous-ly occupied by infected persons, despite terminal cleaning of the bed space. The trend of this phe-nomenon is clearly increasing, so much so that the World Health Organization has taken the issue of patient safety as one of the main objectives of activity worldwide. In the National Prevention Plan 2014-2018 and the National Plan to Combat Antimicrobial Resistance (PNCAR) 2017-2020 the im-portance of prevention and control of infectious diseases and antibiotic resistance is reported. Eve-rything in the foreword refers to strategies aimed at making safer the path of diagnosis and treat-ment for those affected by any disease, it should not be forgotten, however, that the structures of hospitalization and care, hospitals and not only, both public and private, fall within the scope of the legislation concerning the workplace, and must therefore comply with the requirements defined in Chapter I of Title II (art 62-64) of the Consolidated Safety Act. With respect to the general provi-sions applicable to any workplace, there are, however, already in the Legislative Decree 81/08 some important clarifications for certain types of Hospitals. Hospitals are heterogeneous and complex workplaces (outpatients' departments, day hospitals, inpatient units, laboratories, radiotherapy, etc.) and cover a vast range of cases that can be traced back to multiple and sometimes complex work-place risks; in view of the complexity of the workplace, the risks inherent in the various activities must be assessed by studying the work environments and analysing their characteristics, both in-strumental and infrastructural, with the aim of drawing up a Risk Assessment Document that also takes into account interference between one environment and another.

The risk related to equipment in health care, in addition to the possibility that they are a source of fire, must be extended to diagnostic instruments emitting ionizing radiation (equipment for X-rays and radiotherapy), to instruments emitting strong electromagnetic fields (Magnetic Resonance Im-aging) and dangerous instruments and equipment because they are sharp (scalpels and syringes). Moreover, hospitals are by definition the place where bacterial forms are introduced spontaneously (to treat them) and the ability to transmit through the human vector, together with the possible con-dition of reduced immune defenses for pathological or therapeutic causes, make the biological risk one of the most significant in a hospital facility. Equally important is the chemical risk, related to the presence of laboratory substances, drugs, dangerous reagents (chemotherapeutic drugs, narcotics, formaldehyde, etc. ..) that must be maintained, handled and disposed of properly according to standardized procedures, in order to avoid accidental dispersion or improper use. Nurses in particu-lar may also be subject to the risk of manual handling of loads when caring for and lifting non-ambulatory or non-self-sufficient patients; this risk must also be carefully assessed and managed with the aid of mechanical lifting equipment. Finally, there is the risk of Work-Related Stress, linked both to the presence of a strong emotional component and responsibility that can naturally develop in relation to patients, and to the phenomenon known as "burn-out", which is typical of and originates in staff who provide care activities.

All this has led healthcare to seek new strategies and methodologies to adapt to the change brought about by the emergence of new criticalities that increase the risk, unfortunately inevitable, of the status of the person who needs to have his or her health needs met.

So that innovation expresses its full potential it is necessary that the results obtained with it are known and used by those for whom they were designed and to whom they must bring benefits, from this consideration was born the idea of this research project that aims to

develop methods of application intervention and contextualization that supports new technologies in the field of proper management of clinical risk, through the strategies of communication, standardization and simplifi-cation of processes, proper training and information, implementation of traceability tools. As high-lighted by the literature of social sciences, the true innovator is not the one who has the ideas or possesses the techniques, but the one who translates them into concrete facts and, above all, dissem-inates and "communicates" them. In this sense lies the difference between invention (technical fact) and innovation, which is transformed not only into an economic and social product, but also cultur-al. All this has guided the realization of three applications, born from the experience developed in hospital with the participation in the activities of the Clinical Risk, which have shown to implement significantly the safety in the University Hospital "San Giovanni di Dio e Ruggi d'Aragona", of Sa-lerno.

Material and methods

Specifically, the theoretical constructs of the reference scenario represented by modern health care, taking into account the evolution necessary for the management of safety in the hospital, have been made concrete by applying them to three processes of intervention with specific strategies with the aim of optimizing and rationalizing activities for the reduction of hospital infections, through stand-ardization of operating procedures, implementation of tools for medical-legal protection and crea-tion of information and communication packages for health workers.

It was decided to start a path that, starting from hand hygiene and arriving at a deep environmental sanitization, wanted to demonstrate that everything that is well known to be effective in preventing hospital infections, when it is connected in a single project can significantly improve safety in the hospital.

Therefore, for the first application case "Safety starts with hand hygiene", the research hypothesis was to improve hand hygiene through new tools and strategies. Hand hygiene is one of the pillars of the ICA and antibiotic resistance prevention strategy, since contaminated hands of healthcare work-ers are the vehicle most often implicated in the transmission of pathogens between patients in care settings. Despite this, lack of compliance among healthcare workers continues to be a problem worldwide. The World Health Organization has proposed a "multimodal strategy" to improve ad-herence to proper hand hygiene among health care workers, but the laboriousness of the monitoring processes and the moderate impact of training on the technique used can affect and mystify health care worker compliance. The peculiar importance of the topic is even clearer today, a time when the SARS-CoV-2 pandemic continually confronts us with new challenges. At the A.O.U. "San Giovan-ni di Dio e Ruggi d'Aragona" it has been possible to implement and synergize all the techniques and technologies for hand hygiene training: structured audit with the use of "iAuditor", a specific soft-ware for audits that makes it possible to decrease the time needed for monitoring; purchase and use of the device "Semmelweis Scanner", a machine that allows an objective detection of the quality of the sanitization technique with hydro-alcoholic gel; experimentation of the intelligent sink "Soapy Clean Machine", which allows the evaluation of the skills of health care personnel in the field of hand hygiene and simultaneously trains the staff by showing the step-by-step procedure during washing.

The "iAuditor" App is an application that assists the auditing process, allowing the development of all its phases through smartphones and personal computers, has been customized and innovated for the project with the use of digital questionnaires specially made on the iAuditor software, based on those provided for hand hygiene by WHO.
The "Semmelweis Scanner" is a hand scanning device that allows the health worker, after applying a solution based on UVA and alcohol reagent, to quickly visualize the "critical areas" not subjected to an effective sanitation procedure through the use of digital imaging and image processing.
The second tool, the "Soapy Clean Machine", is an automatic station for social hand washing that, once activated, is fully automatic, touch-free, eco-friendly, with customizable washing cycles, dis-pensing the right amount of hot water and soap.
The next step after our general overview of the proper management of safety in the hospital based primarily on strategies for the prevention of hospital infections, has taken into account what could be the margins for improvement of environmental sanitation and what systems to adopt, becoming the second application case called "HCS FAST" procedure. This method, used for our study, is based on the use of an integrated system consisting of disposable cloths pre-impregnated with de-tergent and disinfectant solutions and specific equipment for cleaning operations in hospitals.
The third case study is called "Ozone Disinfection System" which, following several audits that highlighted the need for the company to equip itself with tools for deep sanitization, retraces all the research carried out to identify an equipment easy to use and limited costs for the purchase and management, demonstrating the effectiveness of action to improve environmental sanitation.

Results and Conclusions

The research was initially directed towards overcoming the inherent limitations of the World Health Organization's multimodal strategy "WHO Guidelines on Hand Hygiene in Health Care" and its im-plementation on hand hygiene. To this end, two innovations were introduced at the A.O.U. "San Giovanni di Dio e Ruggi d'Aragona": the digitalisation of monitoring and the technological imple-mentation of the training of health workers. The first was made possible by the use of iAuditor, a specific software for audits that makes it possible to reduce the time needed for monitoring and at the same time expand its possibilities. The first intervention improves the accuracy, accessibility, precision and reliability of the data collected on hand hygiene within the A.O.U. by means of a standardised protocol, in order to obtain a more accurate picture and to be able to carry out targeted interventions, and makes the monitoring and follow-up process more effective and efficient. The "Semmelweis Scanner" devices and the "Soapy Clean Machine" intelligent sink were used for train-ing. It is concluded that the implementation of a dynamic tool (Scanner) to support the hand hy-giene training process of healthcare professionals increases its effectiveness by raising awareness. This conclusion is supported by the statistical analysis that concludes that the improvement achieved after training is statistically significant, which was also found in the total improvement assessment. 170 health workers participated in the study, which allowed us to have a sample of 680 washing ac-tions for each test, since each operator was evaluated on 4 zones of the hand, thus obtaining 680 first assessments and 680 second assessments by summing the assessments of all zones (right palm, left palm, left back and right back). The

average coverage of all zones of the hand obtained at the first assessment for all departments is 92.1% with a standard deviation (σ) of 13.27%. The mean coverage of all areas of the hand obtained at the second assessment for all departments was 97.53% with a standard deviation (σ) of 5.59% (p-value 0.0001). In particular, at the first evaluation 64.56% of the tests were passed, i.e. 439 out of a total of 680, while at the second evaluation the percentage rose to 88.24%, i.e. 600 out of a total of 680. The variation in the number of passes is +23.68%, i.e. +161 passed tests. In addition, it was possible to test the intelligent sink called "Soapy Clean Ma-chine" with the aim of improving hand hygiene compliance, identifying the Neonatal Intensive Care Unit as a pilot ward. The integrated experimentation of the two technologies "Semmelweis Scanner" and "Soapy Clean Machine", although not giving extremely positive results in the short term, in view of the small sample enrolled (23 health workers of the NICU), has however determined an av-erage improvement in the ability of health workers to sanitize their hands. In fact, it was seen that, especially for the backs of the hands, the percentage improvement is promising and therefore it is necessary to plan further cycles of evaluation over time. In light of the above, it can be deduced that the implementation of practical tools (S.Scanner and the Soapy sink) to support the theoretical train-ing process of the health workers on hand hygiene increases the effectiveness in the analysed ward. In particular, the use of these tools promotes an increase in knowledge on the part of the workers, increasing their awareness of proper hand hygiene. In addition, both tools were received by the health personnel with curiosity and interest, in fact, as can be seen from the database the use of Soapy in the first period was very high, then decreasing over time as the interest in the novelty waned. All this has shown that hand hygiene, while remaining a critical moment in the practice of care, can be improved with the possibility of using more tools by increasing compliance in the short term, but to maintain the results over time is necessary dedicated and periodic supervision with pe-riodic and constant training. The use of Scanner and Soapy improves staff training and education, consolidating good practices and progressively increasing employee engagement by making a lasting change in habits. These tools eliminate the "blame factor", i.e. the natural conflict that arises during these types of projects between the observed subject and the observer due to the latter's identifica-tion as a judging entity. Hand hygiene, being a behaviour determined by subjective and cultural as-pects of each individual person, is not easy to modify, even more so if one has to intervene in group dynamics that are established in a complex organisation such as the health sector. The related diffi-culties in convincing operators to change their care practice are widely documented, especially when their culture and/or working context is not change-oriented. It is documented that adherence to good practice is facilitated by methodological support for change. The new training measures are in line with the company's mission and safety culture, spreading the principles of hand hygiene and clean care through the use of technological training tools. They speed up the transition to a lasting behavioural change that involves the entire care team through the empowerment of its individual members. The pathway to change requires multidisciplinary and shared work, accountability for the actions to be taken, and dedicated resources, without which every intervention fails at the outset. A merit of the innovations discussed, which should not be underestimated, is that they have the dual role of assessment technique and training tool. It is possible to use the changes made as a starting point, with more realistic data and training and correction measures to guide the process of continu-ous improvement.

For the next step, we considered a method based on the use of an integrated system consisting of disposable cloths pre-impregnated with detergent and disinfectant solutions and specific equipment for cleaning operations in hospitals, called "HCS FAST". The efficiency of the system adopted was assessed by determining the total bacterial load on the treated surfaces, where a significant reduc-tion in the microbial load was demonstrated, which always fell below the threshold value (standard reference parameters for surface disinfection UNI EN ISO 4833). Traditional systems for the sur-faces analysed, such as the shower tray, bathroom floor and toilet rim, were less than 10% effective, while the pre-impregnated cloths managed to eliminate around 90% of the bacteria present. For ex-ample, on the floor we observed a reduction in the bacterial load from >42 to 10 CFU/11 cm2 with the new method (76% of the colonies were destroyed), while with the traditional method there was a reduction from >42 to 28 CFU/11 cm2 (33% of the colonies destroyed). In addition, the ad-vantages of using this sanitisation system were not limited to sanitising surfaces and limiting cross-contamination, but required the reworking of all activities relating to cleaning and sanitisation opera-tions, including the training and instruction of operators and the traceability of operations.

The innovative cleaning and sanitising protocol used in this study proved to be a viable alternative to traditional cleaning procedures in healthcare. All the tools have been specifically designed to im-prove the efficiency of sanitising and to reduce the problems associated with traditional methods, such as preventing cross-contamination and limiting the physical effort of operators, and avoiding incorrect practices.

With a view to improving hospital environmental hygiene, the third application was carried out us-ing equipment that releases steam or gas with disinfectant efficacy into the environment to reach spaces and cavities that cannot normally be sanitised. Our objective was to develop a practical method using the known antimicrobial properties of ozone to decontaminate the air and surfaces of rooms in healthcare facilities, evaluating the correct procedures focused on safety for patients and professionals. The methodology analysed in this work provided comprehensive evidence on the san-itisation of hospital environments, demonstrating that ozone treatment could be a useful sanitisation process for the hospital infection control programme. Quantitative evaluation of the level of cleanli-ness, using swab cultures on surfaces, revealed a high performance of the proposed method, high-lighting the vital role that infection prevention and control play in improving healthcare systems. Ozone treatment is a very efficient method and increases the infection safety standards of healthcare facilities. The advantages of this device are many: it is easy to use, guarantees a drastic reduction in micro-organisms and ensures the complete inactivation of airborne micro-organisms, preventing subsequent deposition on surfaces. However, cleaning procedures with detergents are an obligatory step before any treatment to completely remove organic matter on surfaces. Despite these limitations, this study provides evidence of an effective and easy-to-use ozone-based disinfection method for critical environments such as hospitals and in particular operating theatres, where the al-ready low bacterial load present is completely eliminated. In this work, the risk of ozone exposure for operators was also assessed and the measures report the total reduction of ozone concentration at the end of the treatment. This system has several advantages for the operator, for the quality of employment and job satisfaction, and helps to protect the environment according to the new param-eters required by current regulations and international guidelines. This work reports, for the first

time, an evaluation of the characteristics of sanitisation with ozone and a measurement of the con-centration of ozone in the air, in the awareness that the health of the operators must be guaranteed as well as that of the patients.

In summary, from the results obtained, the significant reduction in the microbial load, which always falls below the threshold value, demonstrated the effectiveness of the system. In fact, both the air and the surfaces analysed, such as the table, furniture, desk, etc., saw a reduction of around 90% in the micro-organisms present, allowing us to state that the sanitisation method analysed in this work provides complete proof of the effectiveness of ozone in different conditions of temperature, rela-tive humidity and distance. The important aspect highlighted by the research is that ozone treatment is a very efficient method and allows us to raise the safety standards for the control of nosocomial Infections.

In order to evaluate the effectiveness of the interventions carried out, two indicators have been cho-sen, similarly to what is indicated by the international monitoring bodies (O.M.S., E.C.D.C.), the consumption of hydroalcoholic solution, specific for the application case "Safety begins with hand hygiene", and of antibiotics, which becomes a valid indicator for the three case studies.

With regard to the indicator of the consumption of hydroalcoholic solution, it is noted that in recent years the consumption has increased significantly: in 2018 the total consumption amounted to 1,909 litres, in 2019 it stood at 4,023 litres and finally in 2020, also due to the increase in sensitivity on the subject caused by the spread of COVID-19, it came to a total consumption of 12,845 litres. The percentage increase recorded was exponential, going from + 210.73% in 2019 to +319.28% in 2020. As further evidence of the goals achieved, the history of the data for each department also high-lights greater responsibility on the part of the healthcare staff in the "more sensitive" departments, such as Intensive Care or Surgical: the latter, among the main targets of the interventions imple-mented, showed a total gel consumption significantly higher than average and in constant growth over the years.

For the other indicator, which took into account the trend in antibiotic consumption, it emerged that there was an overall reduction in the use of antibiotics, which mainly involved the following mole-cules: amikacin, amoxicillin, amoxicillin-clavulanic acid, cefazolin, ceftriaxone, ciprofloxacin, col-istimethate, gentamicin, levofloxacin, vancomycin, etc., while the only significant increase con-cerned azithromycin, which can also be explained by the prophylaxis of Covid-19 cases in the year 2020. Furthermore, the positive trend was accompanied by a revision of the type of antibiotics used, making the choice of antibiotics to be used in peri-operative prophylaxis more consistent with the guidelines.

In conclusion, it was demonstrated that the strategies proposed in the initial research project, aimed at identifying new communication and methodological methods to implement the safety of patients and healthcare workers, could be used in a concrete way in healthcare facilities. The multifactorial origin of hospital infections, or rather of care-associated infections, identifies the problem as very complex from which to extrapolate the individual variables: type of patient, type of procedure, level of risk, level of invasiveness, level of professional preparation, in order to highlight not only the multiplicity of factors involved, but also, and above all, the critical elements. The correct manage-ment of care-related infections cannot disregard a broader framework of patient and operator safety and at the same time can protect the healthcare company, based on clinical risk techniques and pro-cedures. The prevention of avoidable errors and the containment of their possible harmful

effects constitute the clinical risk management system. A systematic, timely, structured and dynamic ap-proach to risk management contributes to efficiency and to consistent, comparable and reliable re-sults, also in relation to the context. Risk management must continuously respond to change. As ex-ternal and internal events occur and the context changes, the steps of the risk identification, assess-ment and treatment process must be repeated.

In a healthcare system that increasingly has to meet quality criteria, it is impossible to disregard re-quirements such as the formalisation and implementation of a corporate risk management and infra-structure management programme, the promotion of safety and risk management, including proce-dures, guidelines, cleaning and environmental sanitation protocols, the adoption of technical-professional and organisational innovation initiatives. Aspects that in the covid era further highlight the need for a continuous evolution of the contents of the requirements to support the management of infection risk in the healthcare sector. It is known that contaminated environmental surfaces act as reservoirs for microorganisms, increasing the potential risk of cross-contamination through direct and/or indirect patient contact. In addition, in cases of hospital endemicity, it is difficult to solve the problem without also intervening in the environment. Sanitisation is therefore an essential pro-cedure to prevent and contain infectious events during hospitalisation. For the reasons discussed above, the interventions proposed and implemented have made it possible to contain the risk of in-fections related to environmental contamination and incorrect behaviour of healthcare personnel. All the methodologies and tools described in the previous chapters were functional to the implementa-tion of changes in the healthcare organisation by improving its safety. In fact, the promotion of a safety culture among healthcare workers must include a systematic communication and training strategy that requires a preliminary survey to know the starting conditions and then act on the spe-cific aspects for improvement. In particular, fostering the process of transferring the safety culture, with transversal communication strategies, so that it becomes an indispensable component of the in-dividual's professionalism, allows the inclusion of safety aspects also in the purpose or aim of pro-cedures that are developed with other objectives. Communication plays a significant role in all areas of safety promotion for health professionals; in fact, it constitutes a process that determines the ef-fectiveness, efficiency and productivity of the organisation, contributing, if not appropriate, com-plete or transmitted in the most appropriate time and manner, to the emergence of risk factors. In particular, communication in the training phase of health professionals is central to the effectiveness of care processes and to promote a reduction in the risk of serious accidents at work for the care team. The theoretical concepts expressed so far have been applied to the three case studies covered by the research, demonstrating that the integration of these methodologies not only brings undoubt-ed benefits to hospital hygiene but also significantly raises the awareness of health professionals, making them actors of change and not just passive recipients.

From the analysis of the reference scenario and the daily comparison with the health workers, it emerged that, while in the diagnosis and treatment any innovation is quickly accepted and applied, in the activities that provide for actions and behaviour of health workers and health hygiene every-thing is still the same mode that has not undergone innovation in recent times has taken on the char-acteristics of tradition, leading the same operators to the typical statement, so dear to those who manage clinical risk, "it has always been done so", and even

lead them to derision when they re-ceived the proposal to make training on hand hygiene. Therefore, the choice of the line of research, which becomes a continuous line that connects different aspects of hospital infection control, fell precisely on the behaviour of health workers from when they have to sanitise their hands to how to sanitise a hospital, identifying the best strategies to innovate and improve the safety of patients and operators that can be linked to these aspects.

It is also true that, unfortunately, we are living in a particularly challenging period for health care, which does not allow us to claim that the results are replicable over time for the control of hospital infections, but the actions taken have proved to be strategic and even beneficial to combat Sars-Cov 2, having prepared the "San Giovanni di Dio e Ruggi d'Aragona" University Hospital of Salerno, the site of the trial, ready to face the emergency before the pandemic had become global, making it undoubtedly safer.