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EDITORIAL

Postoperative radiological chest exams: requirement *vs.* necessity. Which is superior?

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In 1895 Wilhelm Conrad Röntgen coincidentally discovered a new type of radiation while investigating conduction of electricity in gases referred to as X-rays, X radiation, or Röntgen radiation. The first X-ray pictures showing the bones of the left hand of his wife required an exposition time of 20 minutes. Following its introduction in medicine in 1896 further development of X-ray technology was associated with death of many pioneers in the field of radiology as the severe and lethal side effects remained obscure for many decades. Subsequent development allowed introduction, for instance, of angiography in 1923 and computerized tomography (CT) in 1972. Increased safety and standardized applications adhering to international radiation protection guidelines guarantee beneficial routine application without endangering patients or personal. Radiation rays may liberate electrons from their atomic union, possibly inducing mutations, promoting cell death, and possibly causing non- cancerogenic long- term injuries (*e.g.*, tissue fibrosis, opacity of the eye lens, impaired fertility), as well as cancerogenic and teratogenic alterations. Long-term cancerogenic radiation damage depends on the cumulative radiation exposure aggravated by repetitive radiographs within a short time period. A single chest radiograph increases cancerogenic risk by 0.001% and the risk of fatal cancer is approximately 1 in 250 000.[1] This is extremely low compared to the overall cancer risk and the impact of lifestyle, contributing approximately 25% and 5%, respectively. Probability to suffer from fatal cancer due to diagnostic ionizing radiation strongly depends on administered cumulative dose, age, and time point of exposure.[1-3] To avoid and reduce teratogenic damage, ovaries and testes must be protected in addition to decreasing the number of dispensable radiographs in pregnant women, children, and adolescents.

Annual radiation exposure including natural as well as civilisation- related radiation ranges from 1 to 10 millisievert (mSv) per person. Annual radiation exposure in medicine with approximately 2 mSv is high compared to other sources but remains significantly low compared to the cumulative annual exposure of aircraft crews (8.3 mSv), for instance.[4] The largest part of radiation exposure, however, pertains to few severely ill patients. In daily routine, one chest radiograph accounts for 0.02-0.08 mSv. One CT of the thorax accounts for 6-10 mSv. Thus, radiation exposure of one chest radiograph is very low compared to the naturally occurring radiation within some housing areas (0.6 mSv) and compared to a transatlantic flight (0.1 mSv). Despite the low radiation exposure associated with a single chest radiograph, benefit must always outweigh the calculated risk to prevent iatrogenic harm independent of any technical improvement.

In the current edition of Minerva Anestesiologica, Kröner *et al.* questioned the usefulness of chest radiographs performed within the first hours following elective surgery in patients admitted to the intensive care unit.[5] For this, the authors determined diagnostic and therapeutic efficacy in chest radiographs performed based on routine or clinical suspicion. Overall, therapeutic and diagnostic efficacies were low, ranging from 4% to 18%, respectively. The majority of patients, *i.e.*, 590/ 670=88% received a chest radiograph for no other reason than habitual ordering. In only 12% (80 patients) clinical necessity was present. Temporal profile revealed higher diagnostic and therapeutic efficacy in clinically indicated chest radiographs, providing these radiological studies were performed within the first two hours after admission to the intensive care unit. The majority of expected and coincidentally found abnormalities were malpositioned invasive devices in 96% and 9%, respectively. Interestingly, these findings were only followed by therapeutic consequences in one patient following clinically indicated chest radiograph (1.3%). On the contrary, treatment was altered in 24 patients (4%) with routinely performed chest radiographs. Consequently, a total of 79 malpositioned devices would have been missed (13%) and treatment would not have been adapted in 24 patients (4%) if routine chest radiographs had not been performed.

The incidence of life threatening complications in elective interventions conducted by experienced staff is very low.[6] Routine chest radiographs following removal of chest tubes revealed a low rate of clinical indication for chest radiographs (1.4%) and a low rate of therapeutic interventions in 1.5%.[7] Intubation and tracheostomy do not necessarily require radiographs, especially if positioning of the tubes is controlled bronchoscopically.[8] In cases of difficult insertion with suspected additional injuries, clinical evaluation of subcutaneous emphysema and CT analysis, for instance, are superior to a regular anteroposterior (AP) chest radiograph. Whenever suspected, pneumomediastinum must be excluded by CT. Clinical judgment is essential to justify the increased radiation exposure (CT thorax 6-10 mSv). Following insertion of central venous lines routine chest radiographs aid in assessing correct catheter placement which is important whenever central venous oxygen saturation is used to adapt treatment options and to assure adequate administration of vasoactive drugs. It is important to consider that successful placement determined by ECG-guided insertion does not assure uncomplicated cannulation. With difficult puncture in face of underlying coagulopathy a chest radiograph may be indicated to exclude a hematothorax before clinical deterioration. Correct placement of chest tubes must be determined radiologically. Overall, clinical deterioration is still the best indicator for defined radiological exams aimed at identifying suspected and pre- defined complications.[9] In fact, a recent multicenter, cluster-randomised, two-period crossover study aimed at comparing routine and on-demand prescription of chest radiographs in mechanically ventilated adults convincingly showed that the significant reduction of chest radiographs by 32% using the on-demand strategy maintained patients' quality of care and safety. This strongly supports us to rely on our clinical expertise and to order radiographs based on our own clinical judgement and to abandon performing chest radiographs as a routine reflex upon admission to the ICU.[10] Clinical judgment and degree of suspicion clearly depends on clinical experience. Less experienced colleagues will try to be on the "safe side", thus ordering more radiographs, thereby increasing costs substantially.

Another important issue is the legal justification of not having performed a chest radiograph following clinically indicated interventions which could induce potentially life-threatening complications. Decision making in medicine is also a question of probability. Thus, by nature, the individual response cannot be predicted in all patients and we are faced with the question of exposing, for *e.g.*, 590 patients to unmask 24 patients (=4%) in whom treatment had to be adjusted.[5] Endangering or in the worst case loosing one patient due to missing a correctable complication by omitting a routine chest radiograph because the probability of diagnosing a correctable problem is <5% is not within the scope of our medical duty. Nevertheless, the number of sequential chest radiographs should be limited to an absolute minimum as long as patients show stable vital parameters and functional analysis, as for *e.g.*, blood gases and respiratory parameters exclude an underlying intrathoracic problem. Whether the initial chest radiograph should be omitted cannot be generalized. This strongly depends on the individual course as well as the foresight of having to evaluate sequential chest radiographs for which a baseline chest radiograph is indispensable, especially when this is obtained under stable conditions.

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