Udruženje inžinjera medicinske radiologije u FBiH

Radiološke tehnologije – Časopis iz oblasti radiološke tehnologije

Volumen 17 | Novembar/Studeni 2026. godine

THE IMPORTANCE OF A MOBILE X-RAY DEVICE IN ICU

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Deposited: 02.October. 2026.

Accepted: 28.October.2026.

DOI: https://doi.org/10.48026/issn.26373297.2026.1.17.3

ABSTRACT

Mobile X-ray is one of the most important diagnostic technologies available in the intensive care unit (ICU). Its primary value stems from the ability to perform radiological assessment at the bedside, without transferring a hemodynamically, respiratoryly, or neurologically unstable patient to the radiology department. For the intensivist, mobile radiography is not just a technical procedure, but part of the daily decision-making process: it can quickly verify the position of the endotracheal tube, central venous catheter, nasogastric tube, and chest drain, recognize pneumothorax, atelectasis, pleural effusion, pulmonary edema, or progression of infiltrates, and assess the consequences of intervention. The American College of Radiologists guidelines state that portable chest radiography is an appropriate initial method in the ICU in appropriate clinical circumstances, especially after deterioration of the condition or placement of new tubes and catheters (1). At the same time, mobile X-ray has important limitations: images are most often obtained in the anteroposterior projection, in the supine position, with patient rotation, poor inspiration, and overlapping of numerous medical devices. Therefore, it is not a substitute for computed tomography, lung ultrasound, or clinical assessment. The aim of this paper is to present the importance of mobile X-ray from the perspective of an intensivist, with an emphasis on speed of decision-making, patient safety, diagnostic reach, technical limitations, rational use, and protection from ionizing radiation. In conclusion, the greatest value of mobile X-ray is achieved when the examination is ordered due to a clearly stated clinical question, when it is performed by trained personnel, and when the result is immediately correlated with the clinical findings and other bedside methods.

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Print: ISSN 2232-8726

Online: ISSN 2637-3297

Key words: mobile x-ray; intensive care unit; intensivist; endotracheal tube; central venous catheter; radiation protection

SAŽETAK

Mobilni rendgenski aparat jedna je od najvažnijih dijagnostičkih tehnologija dostupnih u jedinici intenzivnog liječenja (JIL). Njegova osnovna vrijednost proizlazi iz mogućnosti da se radiološka procjena obavi uz bolesnički krevet, bez premještanja hemodinamski, respiracijski ili neurološki nestabilnog bolesnika u radiološki odjel. Za liječnika intenzivista mobilna radiografija nije samo tehnički postupak, nego dio svakodnevnog procesa donošenja odluka: njome se može brzo provjeriti položaj endotrahealnog tubusa, centralnoga venskog katetera, nazogastrične sonde i torakalnog drena, prepoznati pneumotoraks, atelektaza, pleuralni izljev, plućni edem ili napredovanje infiltrata te procijeniti posljedica intervencije. Smjernice American College of Radiologi navode da je prijenosna radiografija prsnog koša u odgovarajućim kliničkim okolnostima prikladna početna metoda u JIL-u, osobito nakon pogoršanja stanja ili postavljanja novih cijevi i katetera (1). Istodobno, mobilni rendgen ima važna ograničenja: snimke se najčešće dobivaju u anteroposteriornoj projekciji, u ležećem položaju, uz rotaciju bolesnika, slabiju inspiraciju i preklapanje brojnih medicinskih uređaja. Zbog toga nije zamjena za računalnu tomografiju, ultrazvuk pluća ili kliničku procjenu. Cilj ovog rada jest prikazati važnost mobilnog rendgenskog aparata iz perspektive intenzivista, s naglaskom na brzinu donošenja odluka, sigurnost bolesnika, dijagnostički doseg, tehnička ograničenja, racionalnu primjenu i zaštitu od ionizirajućeg zračenja. Zaključno, najveća vrijednost mobilnog rendgena ostvaruje se kada se pregled naručuje zbog jasno postavljenog kliničkog pitanja, kada ga izvodi educirano osoblje i kada se rezultat odmah povezuje s kliničkim nalazom i drugim metodama uz krevet bolesnika.

Ključne riječi: mobilni rendgen; jedinica intenzivnog liječenja; intenzivist; endotrahealni tubus; centralni venski kateter; radijacijska zaštita

1. INTRODUCTION

The intensive care unit is an environment in which decisions are made quickly, often on the basis of incomplete information and with a constant risk of sudden deterioration. Patients in the ICU may simultaneously require mechanical ventilation, vasopressor support, renal replacement therapy, invasive hemodynamic monitoring, continuous sedation, and multiple venous or drainage accesses. Each of these procedures can lead to complications that need to be recognized without delay. Bedside radiology therefore has a specific role: it must be fast and accessible enough to answer the clinical question, but at the same time of sufficient quality not to create a false sense of security.

A mobile X-ray machine allows the X-ray source and digital detector to be brought to the patient. In practice, portable chest radiography is most often performed, but depending on the machine and indication, other parts of the body can also be imaged. In the ICU, chest radiography is particularly important because the chest contains the

lungs, heart, mediastinum, and a large number of devices whose position directly affects the safety of treatment. The X-ray image can show the relationship of the tip of the endotracheal tube to the carina, the position of the tip of the central venous catheter, the direction of the nasogastric tube, the condition of the lung parenchyma, and the presence of air or fluid in the pleural space (2-4).

2. THE IMPORTANCE OF MOBILE RADIOGRAPHY

The importance of mobile radiography is best understood in relation to the alternatives. Computed tomography (CT) provides a much more detailed view of the anatomy and is often superior in cases of suspected pulmonary embolism, complex pleural collections, trauma, or unclear thoracic complications. However, CT requires transportation, availability of equipment, and coordination of multiple team members. Lung ultrasound can be performed at the bedside, without ionizing radiation, but is dependent on the experience of the examiner and has a different diagnostic scope. Mobile radiography therefore occupies a middle ground: it is faster and more widely available than CT, is more standardized than many clinical assessments, but is less sensitive and specific for a range of conditions. (1)

From the intensivist's perspective, the question is not whether every patient should get an X-ray every day, but whether a specific X-ray can answer an important clinical question and change the treatment procedure. Such an approach connects the principles of justification and optimization with the needs of the individual patient. Mobile X-ray is valuable when it speeds up a decision, reduces the risk of unnecessary transport or confirms the safety of an invasive procedure; it is less valuable when it is repeated mechanically, without changing the clinical condition and without a clear plan of how the finding will be used. (2)

2.1. The mobile X-ray machine and its place in the ICU

A mobile X-ray machine consists of an X-ray tube and generator that are built into a mobile housing, usually battery-powered, and a digital detector that is placed behind or below the part of the body being scanned. Modern devices enable wireless image transmission to the radiological information system and PACS, so the doctor can review the findings at a workstation or in an electronic chart shortly after exposure. In the ICU, the ergonomics of the machine are also important: the ability to easily maneuver between beds, ventilators, infusion pumps, and other equipment directly affects the speed and safety of the examination.

The most common examination is a portable chest radiograph in anteroposterior projection, performed by a medical radiology engineer. The patient may be in a supine, semi-sitting, or sitting position, depending on hemodynamic stability and ability to cooperate. The detector is placed behind the chest and the X-ray tube in front of the patient. In patients on mechanical ventilation, imaging is often performed during a short inspiratory pause, if the patient's condition and ventilator allow. Before exposure, artifacts should be removed, the patient's identity verified, an appropriate protocol selected, and all team members should be aware of the exposure time. (1)

Print: ISSN 2232-8726
Online: ISSN 2637-3297

It is important for the intensivist to know what mobile radiography can and cannot reliably show. It can document device position, major lung changes, significant pneumothorax, pleural effusion, consolidation, atelectasis, and signs of pulmonary edema. Its interpretation requires knowledge of imaging techniques, as the heart may appear larger on AP images and basal pleural effusion may be difficult to see in the supine position. The decision on the imaging technique is made by the medical radiology engineer. In addition, body rotation, scoliosis, obesity, edema, surgical staples, electrodes, and tubes can limit the assessment. Therefore, the radiological finding must always be viewed in conjunction with clinical data and previous images.

2.2. Accelerating decision-making in intensive care medicine

In the ICU, the time to reliable information can be as important as the information itself. After an intervention, such as intubation, central venous catheter placement, or thoracic drain insertion, the intensivist needs to know whether the procedure was successful and whether there were any complications. Mobile imaging can be performed at the bedside, without waiting for a free appointment in the radiology department and without arranging transport. This does not mean that every imaging must be performed urgently, but rather that the technology allows for rapid answers to questions that could delay treatment in an unstable patient.

2.3. Checking the position of the endotracheal tube

The endotracheal tube is one of the most important devices in the ICU. Its incorrect position can lead to hypoventilation, hypoxemia, unilateral ventilation, atelectasis, airway trauma, or unrecognized esophageal intubation. Clinical examination, including capnography, auscultation and assessment of chest expansion, plays a primary role. The X-ray image complements these data and shows the relationship of the top of the tube to the carina. In the neutral position of the head, in adults, the tip should most often be a few centimeters above the carina, with respect for individual anatomy and changes in position during neck flexion or extension (2,3).

After emergency intubation, mobile X-ray may reveal that the tube is inserted too deeply and is entering the right main bronchus, that the tip is too high near the vocal cords, or that the position is difficult to assess due to insufficient image quality. This finding may then prompt immediate depth correction and rechecking. The same applies after a change in patient position, intrahospital transport, surgery, or unexplained deterioration in oxygenation. However, normal radiographic position does not exclude all ventilation problems, and tube movement may occur even after imaging. Therefore, radiographic findings should not be separated from continuous monitoring of ventilation parameters. (3)

2.4. Checking the central venous catheter

Central venous catheters are used to administer vasopressors, hyperosmolar solutions, parenteral nutrition, blood products, and medications that require reliable central access. Complications of placement include pneumothorax, hemothorax, arterial puncture, bleeding, arrhythmia, and catheter tip malposition. Although ultrasound guidance reduces some complications, it does not eliminate the possibility of intravascular malposition. A review by Roldan and Paniagua warns that unrecognized malposition can be associated with serious morbidity and that standard radiography can sometimes be normal or insufficiently clear, which is why clinical suspicion must lead to additional diagnostics (4,8,9).

Mobile chest radiography in this context has two main roles. The first is to assess the position of the catheter tip in relation to the superior vena cava, cavoatrial junction, or other expected anatomical landmarks. The second is to search for complications, especially pneumothorax after subclavian or jugular puncture. Finding the catheter in an unusual orientation, with a bent tip, or in a peripheral vein may explain poor flow, pain during infusion, or inadequate drug effect. If the finding is equivocal, ultrasound, electrocardiographic guidance, fluoroscopy, or CT should be considered, depending on the clinical situation. (5)

2.5. Nasogastric tube, thoracic drain and other devices

In the ICU, multiple devices are often visualized simultaneously in the thoracic and upper abdominal regions. A nasogastric or orogastric tube should be routed through the esophagus and terminate in the stomach, and a misplaced tube in the airway can have serious consequences. Mobile radiography can help assess its course, although position should not be judged solely by whether the tip appears to be below the diaphragm. A chest drain should be directed toward the appropriate pleural space, and the image may show residual pneumothorax, pleural fluid, atelectasis, or complications following drain placement or removal. The position of a tracheostomy, pulmonary artery catheter, and some other radiologically visible devices can be assessed similarly (4,5).

Post-procedure examination is especially useful when new dyspnea, drop in saturation, increase in oxygen demand, rise in ventilator pressures, hypotension or asymmetry of breath sounds appear. In these situations, the scan does not necessarily provide a definitive diagnosis, but it can quickly direct treatment. For example, a new-onset pneumothorax with hemodynamic instability requires immediate clinical response, while a small and stable pneumothorax may require different monitoring. The intensivist therefore uses radiography as part of dynamic decision-making, not as an isolated document.

Print: ISSN 2232-8726
Online: ISSN 2637-3297

2.6. Lung and heart assessment

A chest X-ray can show a wide range of findings: bilateral interstitial or alveolar opacities in pulmonary edema, focal consolidation, atelectasis, pleural effusion, pneumothorax, signs of hyperinflation, and some forms of cardiac congestion. In patients with acute respiratory distress, serial radiographs may show the direction of change, such as the spread of infiltrates, the development of new basal opacities, or improvement after intervention. However, changes on radiographs often lag behind the clinical event, and overlapping structures make it difficult to distinguish between edema, pneumonia, atelectasis, and hemorrhage.

In acute deterioration of oxygenation, a mobile X-ray can be useful if there is a suspicion of pneumothorax, lung collapse, wrong position of the tube or progression of edema. However, if pulmonary embolism, aortic dissection, small pleural collection or complex infection are suspected, radiography is not sufficient. In such cases, the benefit of CT should be evaluated.

3. MOBILE X-RAY AND REDUCING THE RISK OF INTRAHOSPITAL TRANSPORT

Transporting a critically ill patient to a CT or radiology suite is a complex process that involves transferring from bed to a transport trolley, detaching or replacing equipment, navigating corridors and elevators, and reconnecting to a ventilator, monitor, infusion pumps, and oxygen sources. Each step may be associated with loss of venous access, tube displacement, infusion interruption, hypoxemia, hypotension, hypothermia, or miscommunication. Prospective studies have shown that adverse events occur during intrahospital transport of critically ill patients, and systematic reviews and meta-analyses confirm that the risk is not negligible (6,7). Therefore, expert recommendations emphasize prior stability assessment, appropriate team, equipment, and a communication plan (12).

Mobile X-ray reduces the need for transport when the clinical question is limited to the chest and when the radiographic method is sufficient. This is particularly important in patients on high doses of vasopressors, with severe ARDS, unstable cardiac rhythm, active bleeding, elevated intracranial pressure, or the need for advanced ventilatory support. Avoiding transport can reduce the number of opportunities for technical error and free up the patient stabilization team. In addition, the patient is not exposed to temperature changes, crowds and potential exposure to other hospital infections.

However, mobile X-ray does not mean that the procedure is risk-free. Positioning the detector behind the patient’s back often requires moving, lifting, or turning. This can be challenging for patients with unstable spines, open wounds, drains, or multiple catheters. Therefore, it is important to assess before scanning whether the patient can be positioned safely, whether additional nursing or medical assistance is needed, and whether a plan is in place in case of desaturation or arrhythmia.

From the intensivist's perspective, the best approach involves a brief pre-examination check of: patient identity, indication, current respiratory and hemodynamic stability,

tube and catheter status, ventilation line position, sufficient length of infusion tubing, oxygen availability, and emergency intervention capabilities. The radiologic technologist should be aware that the patient is critically ill, and the intensivist team should respect radiation protection requirements and facilitate smooth operation. Such collaboration shortens procedure time and reduces risk to the patient and staff.

3.1. Diagnostic options and clinical interpretation

The diagnostic value of mobile X-ray depends not only on the device but also on the quality of the imaging, the positioning of the detector, the choice of exposure, and the experience of the person interpreting the findings. Examinations of critically ill patients are often performed in the AP projection and in the supine position, and this approach has limitations compared to the standard upright PA image. The AP projection can increase the apparent size of the heart, and the supine position changes the distribution of pleural fluid and air. Rotation of the patient can mimic lung asymmetry or change the assessment of the mediastinum. Khan et al. emphasize that for proper reading, it is important to first recognize the technical conditions of the image, and then systematically assess the lungs, pleura, heart, bones, and devices (2,3). Comparison with previous images is often more useful than the isolated interpretation of a single image. A sudden change in opacity, a newly formed air margin, tube or catheter displacement, and a change in lung volume may be more important than the absolute size of a single finding.

In a supine pneumothorax, air may accumulate anteriorly or basally, and the typical apical line may not be present. A deep costophrenic angle, increased base transparency, a sharp diaphragmatic edge, or abnormal mediastinal signs may be sought. However, if clinical suspicion is high, a negative or unclear image should not delay ultrasound or urgent treatment. In pleural effusion, a supine image may underestimate the amount of fluid, whereas ultrasound provides a better assessment of free and loculated fluid. In atelectasis, radiography is useful for serial monitoring but may not always distinguish a mucous plug from compression, infection, or other causes.

Mobile radiography is also valuable in monitoring the effect of therapy. It can show the direction of change after a change in ventilation settings, recruitment maneuver, pleural space drainage, diuretic therapy, or treatment of pneumonia. However, the result should be interpreted with caution: radiographic changes may occur with a delay, and the patient's position and the quality of inspiration may create the appearance of deterioration or improvement. If the images are taken serially, it is useful to use a technique that is as uniform as possible to make the comparison more reliable.

Print: ISSN 2232-8726
Online: ISSN 2637-3297

3.2. Advantages of a mobile X-ray machine

The most important advantage of a mobile X-ray is availability at the bedside. In a critical situation, the device comes to the patient, which shortens the time between request, recording and clinical decision. This advantage is especially evident after intubation, placement of a central catheter, thoracic drain or sudden respiratory deterioration. Digital detectors enable rapid image acquisition and reduce the need for repeats due to chemical film processing. The image can be displayed simultaneously to the intensivist and the radiologist, thus facilitating interdisciplinary communication.

Another advantage is the reduction of the need for transportation. The patient remains in a familiar and controlled environment, with access to ventilators, medications, monitors and staff. This is also important organizationally in epidemiological circumstances, for example when it is desired to reduce the movement of patients with respiratory infections through the hospital. The mobile device can also be used in the emergency department, operating room, recovery unit, neonatal or pediatric intensive care unit and in other locations where a stationary device is not available.

A third advantage is its relatively low cost and wide applicability compared to CT. Radiography requires less time, less space, and less logistical preparation. It can be repeated when there is a clear clinical indication and can serve as an initial examination to determine whether further diagnostics are needed. Studies on routine imaging have shown that the finding may lead to a change in treatment in a certain number of patients, especially when there is a postprocedural or clinical indication (10).

3.3. Disadvantages and technical limitations

The main limitation of mobile radiography is its lower quality compared to standard radiography in the radiology suite and CT. The patient is often unable to cooperate, take a deep breath, or assume an upright position. The detector may be misaligned and the X-ray tube may be angled. This results in rotation, shortening, or enlargement of anatomical structures, poor inspiration, and uneven exposure. Obesity, spinal deformities, edema, and bandages further reduce contrast.

Another disadvantage is the overlap of medical devices. Electrodes, ventilation lines, infusion tubes, drains, surgical staples and protective materials can obscure the finding or create artifacts. The intensivist and radiologist must distinguish between a true pathological shadow and a technical artifact. Sometimes the scan needs to be repeated, which increases the dose and prolongs the procedure. Therefore, proper positioning, removal of unnecessary objects and cooperation with the staff are essential for quality.

The third limitation is that mobile X-ray does not display all pathological processes sensitively enough. Early pneumonitis, small amount of pleural fluid, subsegmental atelectasis, pulmonary embolism or complex infection may go unrecognized. In critically ill patients, the findings may be nonspecific, and the same pattern may correspond to different etiologies. Therefore, in case of discrepancy between the radiography and the clinical picture, other methods should be relied on. Ultrasound, echocardiography and CT are not competitors of mobile X-ray, but complementary tools.

The fourth disadvantage is the possibility of excessive use. Routine daily scans without changing conditions can increase the number of exposures, incidental findings and unnecessary additional investigations. A meta-analysis by Oba and Zaza showed that the abolition of systematic daily radiography in adult patients in the ICU did not worsen mortality, length of stay, or the number of days of mechanical ventilation (11). This does not mean that imaging after the procedure or in case of deterioration should be omitted, but that the ordering should be selective and related to the clinical issue.

4. RADIATION PROTECTION IN ICU CONDITIONS

Mobile X-rays use ionizing radiation, so the protection of patients, staff and others is an integral part of every examination. The International Atomic Energy Agency emphasizes the principles of justification and optimization and the application of the basic time-distance-protection approach. In practice, this means that examinations are ordered when the expected clinical benefit outweighs the risk, that the lowest exposure that provides sufficient diagnostic quality is used, and that personnel are removed or protected during exposure (8).

The exposure time should be as short as possible, but the image quality should not be reduced to the point where re-exposure is necessary. Distance is particularly important because the intensity of scattered radiation decreases with distance from the source. When it is not possible to leave the room, staff should stand as far away from the patient and outside the primary beam as possible, using a protective screen or lead apron according to local protocol. The primary beam should be directed so that it does not pass through other patients or unnecessarily exposed persons. The IAEA recommends the use of mobile protective screens where available and that staff who must be present with the patient wear appropriate protection (8).

In the ICU, the challenge is that the space is not designed as a radiology room. Beds are close together, there are many staff present, and it is not always possible to clear the space during an emergency procedure. Therefore, the radiologic technologist needs to clearly warn about the exposure, check who needs to stay with the patient, and position the detector and tube in a way that minimizes scattered radiation. Staff should be educated that a protective apron is not a substitute for distance and proper positioning, and that it should not be in the primary beam.

Patient protection includes avoiding unnecessary repetition, proper centering, collimation, and protocol selection. For repeated exposures, it is important to check whether the change in clinical status is sufficient to justify a new exposure. In children, pregnant women, and patients who have already had many radiological examinations, special attention should be paid to justification and optimization. Responsibility is shared between the physician ordering the examination, the radiological technologist, the radiologist, the medical physicist, and the institution, which must ensure a quality program of equipment protection and control.

Print: ISSN 2232-8726
Online: ISSN 2637-3297

4.1. Technical organization and role of the intensivist

A quality mobile examination begins with a well-worded request. Instead of a general statement such as “check lungs,” it is useful to state a specific question: check endotracheal tube position after intubation, suspected pneumothorax after catheterization, check chest tube position, or new respiratory deterioration. A clear indication helps the radiologist guide the interpretation, and makes it easier for the intensivist to decide what to do with the result.

Before the radiologic technologist arrives, the team should ensure that the bedside space is available, stabilize the tubes and lines, assess whether the patient needs to be temporarily repositioned, and prepare a person to monitor the airway and hemodynamics. Communication with the person operating the ventilator should be maintained during the scan and saturation, blood pressure, and rhythm should be monitored. After exposure, the detector is carefully removed and the patient is returned to a safe position. If the scan is not diagnostic, a decision should be made immediately whether to repeat the scan, supplement it with another projection, or replace it with ultrasound or CT.

The intensivist must also know when it is not enough to wait for the radiological findings. In the case of sudden loss of capnographic signal, severe desaturation, asystole, severe hypotension, or clinical picture of tension pneumothorax, treatment and emergency interventions should not be delayed because of mobile imaging. X-rays should be a tool that supports a safe clinical decision, not a condition that cannot be acted upon without. Once the findings are available, it is useful to document their impact on therapy, especially when a complication is confirmed or when it is decided that additional tests are needed.

4.2. Mobile x-ray in relation to other methods

The most useful way to view mobile radiography is through complementarity. Bedside lung ultrasound can rapidly detect pneumothorax, interstitial syndrome, pleural effusion, and consolidation, and cardiac ultrasound can assess ventricular function, pericardial effusion, and hemodynamic context. Its advantages include the absence of radiation and the possibility of repetition, but the finding depends on the skill of the examiner, the examination window, and the availability of the device. CT provides anatomical and functional resolution that radiography cannot achieve, but the cost is higher dose, transportation, and the need for organization.

When a device complication is suspected, mobile radiography is often the first step. If it shows obvious malposition or pneumothorax, it can allow for rapid treatment. If the finding is unclear, clinical symptoms may direct the patient to ultrasound or CT. In acute respiratory distress, radiography is useful for quickly identifying some reversible causes, but capnography, gas analysis, ultrasound, and echocardiography should not be neglected. The correct method is not always the one with the greatest technological complexity, but the one that answers the specific question most quickly and reliably with acceptable risk.

4.3. Future development of mobile radiography

The development of digital detectors, better image processing algorithms, wireless connectivity and artificial intelligence can further improve mobile radiography. Systems for automatic marking of the tip of an endotracheal tube, central catheter or suspected pneumothorax can aid triage and reduce the risk of overlooking an urgent finding. However, such systems should not replace expert interpretation. Their value will depend on the quality of the data, proper validation in real ICUs, understanding of false positives and false negatives and clear assignment of responsibilities.

Possible developments include mobile digital tomosynthesis or spectral radiography, which could reduce structural overlap and improve the presentation of individual findings. Such technologies may be useful in patients who are not candidates for transport, but their availability, cost, dose, and educational requirements must be compared with existing methods. The future is not necessarily about every patient getting a more sophisticated device, but rather about the team getting more reliable information with the least possible burden on the patient.

5. DISCUSSION

The analysis of the available literature shows that mobile radiography has an important, but clearly limited, role in the intensive care unit. Its value does not stem only from the possibility of obtaining a radiographic image, but primarily from the availability of diagnostics right at the patient's bedside. In circumstances where the patient's condition can change in a matter of minutes, the speed of obtaining information can directly influence the decision to continue ventilation, correct the position of the medical device, place a chest drain or the need for additional diagnostics. The mobile X-ray machine should therefore be seen as an integral part of the intensive care system, and not just as a replacement for the standard device located in the radiology department.

The results of the literature review confirm that the most important indications for mobile radiography are related to a sudden deterioration in clinical condition and verification of the position of medical devices. The American College of Radiology guidelines state that mobile chest radiography is an appropriate initial method in a number of clinical situations in the ICU, especially after the placement of new tubes and catheters or the development of new respiratory symptoms (1). This approach is consistent with the daily practice of intensivists, as it allows for the rapid differentiation of several possible causes of deterioration, such as endotracheal tube malposition, pneumothorax, atelectasis, pleural effusion, or pulmonary edema.

Checking the position of the endotracheal tube is one of the clearest examples of the clinical utility of mobile radiography. Although the regularity of the intubation is directly assessed by capnography, auscultation and clinical examination, the X-ray allows the assessment of the depth of the tube and its relation to the carina. This can identify a tube placed too high or too deep and endobronchial intubation, which can cause unilateral ventilation and consequent atelectasis (2,3). However, radiography should not replace immediate methods of confirming intubation. Waiting for an X-ray in

Print: ISSN 2232-8726
Online: ISSN 2637-3297

a patient without an adequate capnographic signal or with severe hypoxemia could delay the necessary intervention. Its role is therefore confirmatory and supplementary, not primary in the assessment of airway patency.

Similar principles can be applied to central venous catheters. Mobile radiography allows assessment of the catheter's direction and final position and detection of complications, especially pneumothorax after jugular or subclavian access. Roldan and Paniagua warn that intravascular malposition of a central venous catheter may remain clinically unrecognized, and its consequences may be serious (9). However, radiographic assessment also has limitations. A two-dimensional image may not always reliably show whether the catheter is in the expected vein, and an apparently acceptable position on radiographs does not exclude all forms of malposition. If there is a discrepancy between the radiographic finding and clinical indicators, such as poor flow, pain during infusion, unusual pressure, or inability to aspirate blood, additional diagnostic workup is necessary.

The importance of mobile radiography is particularly evident in the prevention of complications associated with the transport of critically ill patients. Intrahospital transport is not simply the movement of patients from one area to another, but a complex process during which ventilatory, hemodynamic, and drug support must be maintained. Studies have shown that hypoxemia, hypotension, arrhythmias, infusion interruptions, loss of venous access, and displacement of the endotracheal tube or other devices can occur during transport (6,7). The risk is particularly high in patients with severe acute respiratory distress syndrome, high doses of vasopressors, unstable heart rhythm, or elevated intracranial pressure.

When the clinical question can be satisfactorily resolved by chest radiography, performing the examination at the bedside is a safer and organizationally simpler option. This avoids separating the patient from the ICU equipment and staff and reduces the number of situations in which a technical error may occur. Nevertheless, the mentioned advantage should not lead to the postponement of CT when it is clinically necessary. Mobile radiography cannot reliably exclude pulmonary embolism, aortic dissection, complex thoracic injury, small or loculated pleural collection, and a number of other conditions. The decision to avoid transport must therefore be based on an assessment of whether a mobile examination can really answer the clinical question, and not just on the fact that it is easier to organize.

An important issue emerging in the literature concerns the justification for routine daily radiography of all patients in the ICU. Older studies have shown that routine transthoracic radiography may reveal unexpected findings and in some cases lead to changes in treatment (10). However, subsequent studies and meta-analyses have not shown that omitting routine daily radiography increases mortality, prolongs mechanical ventilation, or prolongs ICU stay (11). These results support a selective approach, in which examination is performed after a specific intervention or clinical change occurs, rather than automatically according to a daily schedule.

Selective ordering does not mean reducing the availability of radiographs or abandoning patient follow-up. It means that each request should include a clear clinical

question and the expected consequence of the findings. For example, justified indications include new deterioration in oxygenation, increased ventilatory pressures, asymmetry of breath sounds, suspected tube displacement, hypotension after central venous catheter placement, or assessment of the effect of thoracic drainage. In contrast, repeating an image without a change in clinical status and without the intention of changing therapy is of limited value. This approach reduces unnecessary radiation exposure, staff workload, and the possibility of incidental findings that may lead to additional investigations without clear benefit.

The diagnostic value of mobile radiography also depends on the technical quality of the image. Unlike standard posteroanterior radiography, mobile radiography in the ICU is most often performed in an anteroposterior projection, in the supine or semi-sitting position. Such a projection may appear to enlarge the cardiac shadow, while insufficient inspiration may mimic basal infiltrates or worsen the appearance of existing opacities. Patient rotation alters the view of the mediastinum and lung fields, and overlapping electrodes, tubes, drains, and infusion lines further complicates interpretation (2,3).

Due to these limitations, a negative or unclear finding should not be automatically interpreted as the absence of disease. Pneumothorax in a bedridden patient may have an atypical appearance because air accumulates anteriorly and basally, while pleural effusion is distributed posteriorly and may be underestimated. Differentiation between pneumonia, atelectasis, pulmonary edema, and alveolar hemorrhage can also be difficult because these conditions produce similar radiographic opacities. The greatest diagnostic confidence is achieved by comparison with previous images, systematic assessment of technical quality, and correlation of findings with the clinical picture.

The results of the reviewed papers also highlight the importance of collaboration between intensivists, radiologists, radiologic technologists, and nurses. The intensivist must clearly define the indication, ensure patient stability during positioning, and correlate the radiographic findings with other clinical data. The radiologic technologist is responsible for proper centering, collimation, exposure, and protection of persons in the space, while the radiologist provides expert interpretation, especially in complex or ambiguous findings. Nurses play an important role in protecting tubes, catheters, drains, and infusion lines during patient movement. Lack of coordination can reduce the benefit of the examination and at the same time increase the risk of complications.

Radiation protection further confirms the need for rational use of mobile X-ray. A single chest X-ray is associated with a relatively low radiation dose, but critically ill patients may be exposed to a large number of radiological procedures during treatment. In addition to the patient, it is necessary to protect healthcare workers and other patients in the vicinity. Application of the principles of justification and optimization, proper collimation, avoidance of repeated exposures and maintaining an appropriate distance are the basis for safe use (8). Based on all of the above, it can be concluded that future development of practice should not be directed towards increasing the total number of images, but towards improving their justification, quality and speed of interpretation. Standardized protocols, education of intensivists on the systematic reading of portable images, better communication with the radiology team and clear criteria for switching

Print: ISSN 2232-8726
Online: ISSN 2637-3297

to ultrasound or CT can increase diagnostic benefit. A mobile X-ray machine is most valuable when it enables timely and safe decisions, but with constant awareness of the limits of the method.

6. CONCLUSION

The mobile X-ray machine has an important and well-defined role in the intensive care unit. Its greatest value for the intensivist is the ability to quickly obtain radiological information at the patient's bedside, especially after intubation, placement of a central venous catheter, thoracic drain or in case of sudden respiratory and hemodynamic deterioration. This can speed up the correction of the wrong position of the device, recognize pneumothorax or atelectasis, and reduce the need for risky transport of a critically ill patient. It is important to note that the mobile X-ray device is operated and taken by a medical radiology engineer exclusively.

The advantages, however, should not obscure the limitations. Portable imaging is often AP and supine, technically demanding, and artifact-laden. It cannot reliably exclude all serious diseases and is not a substitute for CT, ultrasound, echocardiography, or clinical assessment. Routine routine imaging without a clear indication may result in unnecessary radiation exposure and additional procedures, so a selective approach focused on a specific clinical question is preferable.

Safe application requires the cooperation of intensivists, radiologists, radiologic technologists, nurses and medical physicists. Standardized protocols, good communication, equipment quality control, proper positioning, principles of justification and optimization, and consistent application of time-distance-protection are needed (8,12). When used judiciously and at the right moment, a mobile X-ray is not only a practical replacement for a stationary device, but an important tool for safer and faster treatment of critically ill people.

LITERATURE

1. Expert Panel on Thoracic Imaging, Laroia AT, Donnelly EF, Henry TS, Berry MF, Boiselle PM, et al. ACR Appropriateness Criteria® Intensive Care Unit Patients. J Am Coll Radiol. 2021;18(5 Suppl):S62-S72. doi:10.1016/j.jacr.2021.01.017.
2. Khan AN, Al-Jahdali H, Al-Ghanem S, Gouda A. Reading chest radiographs in the critically ill (Part I): normal chest radiographic appearance, instrumentation and complications from instrumentation. Ann Thorac Med. 2009;4(2):75-87. doi:10.4103/1817-1737.49416.
3. Khan AN, Al-Jahdali H, Al-Ghanem S, Gouda A. Reading chest radiographs in the critically ill (Part II): radiography of lung pathologies common in the intensive care unit. Ann Thorac Med. 2009;4(3):149-157. doi:10.4103/1817-1737.53349.
4. Baratella E, Marrocchio C, Bozzato AM, Roman-Pognuz E, Cova MA. Chest X-ray in intensive care unit patients: what there is to know about thoracic devices. Diagn Interv Radiol. 2021;27(5):633-638. doi:10.5152/dir.2021.20497.
5. Gupta PK, Gupta K, Jain M, Garg T. Postprocedural chest radiograph: impact on management in critical care unit. Anesth Essays Res. 2014;8(2):139-144.
6. Parmentier-Decrucq E, Poissy J, Favory R, Nseir S, Onimus T, Guerry MJ, et al. Adverse events during intrahospital transport of critically ill patients: incidence and risk factors. Ann Intensive Care. 2013;3:10. doi:10.1186/2110-5820-3-10.

7. Murata M, Nakagawa N, Kawasaki T, Yasuo S, Yoshida T, Ando K, et al. Adverse events during intrahospital transport of critically ill patients: a systematic review and meta-analysis. Am J Emerg Med. 2022;52:13-19. doi:10.1016/j.ajem.2021.11.021.

8. International Atomic Energy Agency. Radiation protection and safety in medical uses of ionizing radiation. IAEA Safety Standards Series No. SSG-46. Vienna: IAEA; 2018

9. Roldan CJ, Paniagua L. Central venous catheter intravascular malpositioning: causes, prevention, diagnosis, and correction. West J Emerg Med. 2015;16(5):658-664. doi:10.5811/westjem.2015.7.26248.

10. Brainsky A, Fletcher RH, Glick HA, Lanken PN, Williams SV, Kundel HL. Routine portable chest radiographs in the medical intensive care unit: effects and costs. Crit Care Med. 1997;25(5):801-805.

11. Oba Y, Zaza T. Abandoning daily routine chest radiography in the intensive care unit: meta-analysis. Radiology. 2010;255(2):386-395. doi:10.1148/radiol.10090946.

12. Fanara B, Manzon C, Barbot O, Desmettre T, Capellier G. Recommendations for the intra-hospital transport of critically ill patients. Crit Care. 2010;14:R87. doi:10.1186/cc9018.

Print: ISSN 2232-8726
Online: ISSN 2637-3297