

Chemotherapy Safety and Extravasation

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THE STORY IN ONE SENTENCE

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“Check the IV site every time. Burning, swelling, or redness means stop the infusion right now.”

Normal anatomy — the body's job

Chemotherapy drugs flow through an IV catheter placed inside a vein, so the medicine travels safely through the bloodstream to reach cancer cells all over the body without touching healthy tissue directly.

BODY'S JOB

The vein is like a protected highway that carries the chemo everywhere it needs to go. The IV catheter (a thin plastic tube) sits inside the vein, so every drop of medicine goes straight into the blood. The blood dilutes the chemo and moves it quickly away from the injection spot, which keeps it from burning any one place. Healthy tissue around the vein never touches the drug because the vein wall acts as a barrier.

1. The nurse places a thin plastic catheter through the skin into a vein, usually in your arm or hand.
2. The catheter tip sits inside the vein, floating in the stream of blood.
3. Chemotherapy flows through the catheter into the bloodstream.
4. Blood carries the drug away from the injection site within seconds, spreading it safely through the whole body.
5. The vein wall keeps the drug separated from the skin, muscle, and fat around it.

What breaks

The IV catheter slips out of the vein, or the vein tears, so chemotherapy leaks into the tissue around it instead of staying in the bloodstream.

CLINICAL TERM

Extravasation occurs when the IV catheter dislodges from the vein or the vein wall ruptures, allowing vesicant chemotherapy agents (anthracyclines like doxorubicin, vinca alkaloids like vincristine, mitomycin, or taxanes) to infiltrate surrounding subcutaneous tissue and cause chemical burns and tissue death (necrosis).

How the body compensates

The body tries to protect itself by sending fluid and immune cells to the leak site to dilute and wall off the poison, but this response cannot stop vesicant drugs from killing tissue — only fast recognition and treatment can limit the damage.

1. {'what': 'Burning pain starts immediately.', 'why': 'Chemotherapy outside the vein triggers nerve endings in the tissue, signaling 'danger — something is wrong here.' This is the body's alarm system telling you to stop the infusion.', 'clinical': 'Pain is often the first sign, appearing within seconds to minutes of extravasation, and is reported in up to 95% of cases with vesicant agents.'}
2. {'what': 'Blood vessels in the area dilate and leak fluid, causing redness and swelling.', 'why': 'The body sends more blood to the area to try to dilute the poison and carry it away, and immune cells release chemicals that make blood vessels leaky so white blood cells can get into the tissue to clean up. This is the same inflammatory response you see with any injury.', 'clinical': 'Local inflammation appears within minutes to hours. Redness (Erythema) and swelling (edema) are visible early signs, but they do not predict how deep the injury will go.'}
3. {'what': 'Tissue swelling increases pressure, which compresses veins and blocks blood flow.', 'why': 'The tissue space is surrounded by tough connective tissue that does not stretch much, so when fluid builds up, it squeezes everything inside — including the vein the IV is in. This is why blood stops flowing back through the catheter.', 'clinical': 'Loss of IV patency or inability to aspirate blood is a late sign that extravasation has progressed. By this point, significant drug has already leaked.'}

4. {'what': 'Cells in the area die, forming an area of dead tissue called tissue death (necrosis).', 'why': 'Vesicant chemotherapy drugs bind to DNA and cell proteins, killing any cell they touch. Unlike cancer cells that are far away, the skin and muscle cells right at the leak site have no way to escape. The tissue turns black or forms an open wound over days to weeks.', 'clinical': 'Anthracyclines cause progressive tissue death (necrosis) that can extend for weeks after the initial injury. Tissue breakdown may not be visible for 48 to 96 hours, even though the damage started immediately.'}
5. {'what': 'The body tries to wall off the dead tissue by forming scar tissue around it.', 'why': 'Your immune system cannot repair cells killed by chemotherapy, so it builds a barrier of scar tissue to separate the dead zone from healthy tissue and prevent infection from spreading.', 'clinical': 'Even with treatment, severe extravasation can require surgical debridement (cutting out the dead tissue) and skin grafting to close the wound.'}

Domino effect

1. The IV catheter slips out of the vein or the vein wall tears during chemotherapy infusion. — Catheters can shift when the patient moves their arm, or veins can rupture if they are fragile from age, prior chemotherapy, or repeated needle sticks. The plastic catheter is stiff and can poke through the delicate vein wall.
2. Chemotherapy flows into the tissue space (under the skin and around muscle) instead of into the bloodstream. — Once the catheter tip is outside the vein, every drop of chemo that flows through the IV line goes straight into the tissue. The tissue has no barrier to protect it, so the drug spreads through the space like water soaking into a sponge.
3. The chemotherapy touches living cells and immediately starts killing them, just like it kills cancer cells. — Vesicant chemotherapy drugs work by binding to DNA and stopping cells from dividing. They cannot tell the difference between a cancer cell and a healthy skin or muscle cell, so they kill whatever they touch.
4. Nerve endings in the tissue send pain signals, and the patient feels burning or stinging at the IV site. — The dying cells release chemicals that activate pain receptors. This is the earliest warning sign — often appearing within seconds — and it means the infusion must be stopped immediately.
5. Blood vessels in the area open wide and leak fluid, making the tissue swell and turn red. — The body senses an injury and sends more blood to the area to try to wash the poison away. Blood vessels become leaky so immune cells can get into the tissue to start cleaning up. This is the same response you see when you get a cut or burn.

6. The swelling squeezes the vein shut, so the IV stops working and you cannot draw blood back through it anymore. — The tissue space does not stretch much, so when it fills with fluid, the pressure builds up and collapses the vein. This is why loss of blood return is a red flag for extravasation — it means the pressure outside the vein is higher than the pressure inside it.
7. Over hours to days, the tissue that was touched by the chemotherapy dies and turns into a black or purple wound. — The cells cannot recover once their DNA is damaged by the chemo. Dead tissue loses its blood supply and turns dark, then breaks down into an open sore. Anthracyclines like doxorubicin can cause tissue death that spreads deeper over weeks because the drug stays in the tissue and keeps killing cells.
8. Without treatment, the wound gets bigger, deeper, and may get infected, sometimes requiring surgery to remove dead tissue and cover the area with a skin graft. — Dead tissue cannot heal on its own and becomes a breeding ground for bacteria. The body walls it off with scar tissue, but the wound will not close unless the dead tissue is cut out and healthy tissue is moved in to replace it.

Symptoms · what the patient feels, and why

- Swelling at the IV site: The chemotherapy medicine leaked out of the vein into the surrounding tissue, causing fluid to collect under the skin.
- Pain or burning at the IV site: The leaked chemotherapy irritates the tissue outside the vein, triggering pain nerves because the tissue is not meant to touch these strong medicines.
- Redness around the IV site: Blood vessels in the area widen and bring more blood to the injured tissue, making the skin look red as the body tries to respond to the chemical damage.
- Skin feels tight or stretched: Fluid and swelling push against the skin from below, stretching it like a balloon being filled with water.
- The IV drip slows down or stops: When medicine leaks into tissue instead of flowing through the vein, pressure builds up and blocks the fluid from moving forward smoothly.
- No blood return when the IV is checked: The IV catheter (the tiny tube inside the vein) has slipped out of the vein or the vein has collapsed, so blood cannot flow back through the tube.
- Skin blanching (turning white or pale): Leaked medicine can squeeze or damage tiny blood vessels under the skin, cutting off blood flow and making the tissue look pale or white.
- Blistering or skin breakdown (delayed, hours to days later): Some chemotherapy drugs are so toxic to tissue that they kill skin cells, causing blisters or open sores to form as the damaged tissue dies.

Focused exam

- Burning pain at the IV site during chemo infusion: Chemotherapy drugs are made to kill cells. When they leak out of the vein and touch normal skin, they burn and damage it just like they would damage a tumor. This burning is your earliest and most important warning that the IV has slipped out of the vein. Catching it now—in the first few minutes—stops the drug from going deeper and killing more tissue.
- Swelling (puffiness) around the IV needle that grows over minutes: When chemotherapy leaks into tissue, the body floods the area with fluid to try to wash out and dilute the poison. Extravasation swelling is different from normal IV swelling: it appears fast (within minutes), spreads wide, and hurts. Normal IV swelling is slow, small, and does not burn.
- Redness or darkening of the skin around the IV site: Red skin means the body has sent immune cells to fight the damage and clean up dying tissue. Dark red or purple skin means blood vessels are breaking and tissue is starting to die. The color tells you how deep and how bad the injury already is.
- Blood does not come back through the IV when you pull the plunger gently: A working IV sits inside the vein, so you can pull blood backward into the syringe. If no blood comes back, the needle tip has slipped out of the vein and is sitting in fat or skin. That means chemotherapy is leaking into tissue right now, not flowing safely into the bloodstream.
- Hardness or firmness of tissue under and around the IV site: Hard tissue means chemotherapy has already killed a pocket of cells and the body is starting to wall off the dead zone with scar tissue. This firmness tells you the extravasation is not just surface-level—it has gone deep.
- Patient says the IV site hurts more than it did a few minutes ago: Pain that gets worse during the infusion—not better—is the clearest sign that chemotherapy is leaking out of the vein and damaging tissue. Believe the patient. Do not wait to see if it gets better on its own, because it will not.

Diagnostics · every test answers a question

- Visual inspection and measurement of the extravasation site with a ruler → How big is the area of swelling and redness right now?
- Photography of the IV site immediately and every 24 hours → Is the injury getting bigger or staying the same over the next few days?
- Tissue hardened tissue (induration) (hardness) assessment by gentle examining by touch (palpation) → Has the leaked chemotherapy killed tissue deep under the skin?
- Review of the chemotherapy drug class (vesicant vs. irritant vs. non-vesicant) → How dangerous is this specific drug if it leaks into tissue?

- Volume of chemotherapy extravasated (estimated from the infusion pump or IV bag) → How much chemotherapy leaked out before the IV was stopped?
- Serial neurovascular checks (sensation, movement, capillary refill, pulses) in the affected limb → Is swelling so bad that it is cutting off blood flow or nerve signals?

Treatment logic

- Stop the IV infusion immediately and do not remove the needle yet → Stops more chemotherapy from leaking into the tissue. This is the single most important step because every second the IV runs, more poison goes where it should not go and kills more cells.
- Aspirate (gently pull back) as much fluid as possible through the IV needle before removing it → Removes some of the leaked chemotherapy from the tissue before it spreads deeper. This can lower the total amount of drug sitting in the tissue and reduce the size of the injury.
- For anthracycline extravasation: give dexrazoxane IV within 6 hours (day 1: 1000 mg/m², day 2: 1000 mg/m², day 3: 500 mg/m²) and apply cold packs for 15–20 minutes four times daily → Dexrazoxane is an antidote that stops anthracyclines (like doxorubicin) from killing more tissue by blocking the chemical reaction that damages DNA inside cells. Cold packs slow down blood flow and keep the drug from spreading. This combination reduces the risk of tissue death (necrosis) (tissue death) and the need for surgery.
- For vinca alkaloid or taxane extravasation: inject hyaluronidase (150–900 units total, divided into 5–6 small injections around the extravasation site) and apply warm packs for 15–20 minutes four times daily → Hyaluronidase is an enzyme that breaks down hyaluronic acid, the 'glue' holding tissue together. This lets the leaked chemotherapy spread out thin over a larger area instead of staying concentrated in one deadly pocket. Warmth increases blood flow so the body can carry the drug away faster. This reduces tissue death and ulcer formation.
- Mark the border of the swelling and redness with a pen, take a photograph, and refer to a plastic surgeon within 24 hours → The pen mark and photograph show exactly how big the injury is right now, so the medical team can see if it grows over the next few days. The plastic surgeon examines the site and decides whether dead tissue needs to be cut out (debridement) or whether a skin graft will be needed later.
- Elevate the affected limb above the level of the heart → Gravity helps drain fluid away from the extravasation site, which reduces swelling and lowers pressure in the tissue. Lower pressure means less pain and a smaller chance of compartment syndrome (pressure crushing nerves and blood vessels).

- Use a central venous catheter (port or PICC line going into a large vein near the heart) instead of a peripheral IV for vesicant chemotherapy drugs → Central lines deliver chemotherapy into a large, fast-moving blood vessel that dilutes the drug instantly. If a tiny leak happens, the drug is diluted so quickly that it does not kill tissue. This prevents extravasation from happening in the first place. Current guidelines recommend central lines for all anthracyclines, vinca alkaloids, and other vesicants.

Medications

Dexrazoxane · Anthracycline extravasation antidote

Dexrazoxane grabs iron particles (tiny metal pieces) out of anthracycline molecules. Anthracyclines (like doxorubicin, the 'red devil' chemo) create damaging oxygen fragments called free radicals—like sparks flying off a grinding wheel—but only when iron is attached. When dexrazoxane removes the iron, the drug cannot make those sparks, so tissue damage stops spreading.

1. Dexrazoxane enters the area where anthracycline has leaked out of the vein into surrounding tissue.
2. It binds to (sticks onto) iron atoms that are part of the anthracycline drug molecule.
3. By grabbing the iron, dexrazoxane stops the anthracycline from creating free radicals (harmful oxygen sparks that burn nearby tissue).
4. Tissue breakdown slows and then stops, preventing the deep ulcer (open wound) and tissue death (necrosis) that otherwise happen over days to weeks.

SAFETY WATCH

Must be given within 6 hours of the leak for best results; after that window it may not help. · Give through a NEW IV line in a different arm or vein—never through the site where the leak happened. · Can lower white blood cell and platelet counts (bone marrow suppression), so watch blood counts closely. · Do NOT use cold packs after the first dose of dexrazoxane is given—cooling can make the drug less effective. · Do NOT give if the patient is pregnant, as it may harm the baby.

Hyaluronidase · Vinca alkaloid and other hyperosmolar drug extravasation antidote

Hyaluronidase is an enzyme (a protein that speeds up chemical reactions) that breaks apart hyaluronic acid, a thick gel-like substance that holds cells together in tissue. When chemo leaks into skin, it gets trapped in that gel. Hyaluronidase dissolves the gel, creating temporary

channels so the leaked drug can spread out and drain away through lymph vessels (tiny drainage tubes in tissue) instead of sitting in one spot and killing a big patch of skin.

1. Hyaluronidase is injected into and around the area where the vinca alkaloid (like vincristine or vinblastine) or hyperosmolar drug has leaked.
2. The enzyme breaks down hyaluronic acid strands that form the gel between cells.
3. The gel dissolves, opening up spaces and pathways in the tissue.
4. The leaked chemo drug spreads out over a larger area and drains into lymph vessels, lowering the concentration in any one spot.
5. With the drug diluted and dispersed, tissue damage is less severe.

SAFETY WATCH

Inject into the tissue around the leak site—NOT into a vein. · Use warm (not hot) compresses after giving hyaluronidase to help the drug spread and absorb; do NOT use cold packs. · Watch for allergic reactions (rare)—redness, hives, or trouble breathing. · Do NOT give to patients allergic to bee or wasp stings, as hyaluronidase comes from animal tissue and may cross-react. · Mark the leak area with a pen so you can watch for spreading redness, blistering, or skin breakdown over the next 48–72 hours.

Topical cooling (cold packs) · Local tissue protection measure for anthracycline and alkylating-agent extravasation

Cold narrows blood vessels (vasoconstriction—like turning down a faucet) and slows down cell metabolism (the speed at which cells work and use energy). When anthracycline or an alkylating agent (like mechlorethamine) leaks into tissue, cells pick up the drug faster if they are warm and active. Cooling the area makes cells sluggish and closes off small blood vessels, so less drug enters cells and less damage happens.

1. A cold pack (or ice wrapped in a thin towel) is placed on the leak site.
2. Blood vessels in the area narrow, reducing blood flow and delivery of the leaked drug deeper into tissue.
3. Cell metabolism slows, so cells take up less of the drug.
4. The drug stays more localized and causes less widespread injury.

SAFETY WATCH

Apply cold for 15–20 minutes, four times a day, for 24–48 hours (or as directed by institutional protocol). · Do NOT apply ice directly to skin—always wrap in a towel to prevent frostbite. · Do NOT use cold packs if dexrazoxane will be given for anthracycline leak; cooling may reduce dexrazoxane effectiveness. · Stop cooling if skin becomes numb, white, or painful—these are signs of cold injury.

Topical warming (warm packs) · Local tissue protection measure for vinca alkaloid, taxane, and etoposide extravasation

Warmth opens (dilates) blood vessels and speeds up cell metabolism, increasing blood flow and lymphatic drainage (the flow of fluid through tiny drain channels in tissue). For drugs like vinca alkaloids and taxanes that bind tightly to cells and stay put, warmth helps the body flush the drug away faster, reducing the total dose any one patch of tissue sees.

1. A warm (not hot) pack is placed on the leak site.
2. Blood vessels dilate (widen), increasing blood flow to carry drug away.
3. Lymphatic vessels open and drain more fluid, dispersing the drug over a larger area and into circulation.
4. The concentration of drug at the leak site drops, lowering tissue damage.

SAFETY WATCH

Apply warmth for 15–20 minutes, four times a day, for 24–48 hours (or per protocol). · Use a warm (not hot) compress or heating pad on LOW setting to avoid burns. · Check skin frequently—stop if redness, blistering, or pain increases. · Do NOT use warm packs for anthracyclines, alkylating agents, or mitomycin—use COLD instead.

Dimethyl sulfoxide (DMSO) topical · Free-radical scavenger and anti-inflammatory for anthracycline extravasation (used outside the U.S.; not FDA-approved for this indication)

DMSO is a liquid that soaks through skin and grabs free radicals (harmful oxygen sparks created by anthracyclines) before they can damage tissue. It also reduces inflammation (swelling and immune-cell attack) at the leak site. By mopping up free radicals and calming the immune response, DMSO lowers the chance of deep ulcers and tissue death.

1. DMSO solution (typically 99% strength, diluted to 50–75%) is applied to the skin over the leak.
2. DMSO penetrates the skin barrier and enters the tissue.
3. It binds to and neutralizes free radicals produced by the anthracycline.

4. It also blocks inflammatory signals, reducing swelling and immune-cell recruitment.
5. Tissue damage slows and may stop.

SAFETY WATCH

Apply to clean, dry skin; let air-dry (do NOT cover with a bandage immediately). · Causes a garlic-like odor on the breath and skin—warn the patient this is normal. · May cause skin irritation, redness, or itching at the application site. · Do NOT use with cold or warm packs at the same time unless specified by protocol. · Not widely used in U.S. practice; check your institution's extravasation protocol before applying.

Red flags

- Swelling, pain, or burning at the IV site during or right after chemotherapy
- Skin turns pale, blanched, or develops blisters near the IV
- No blood flows back when the IV line is checked
- The IV pump alarm goes off or the drip suddenly slows or stops

Nursing priorities

1. Stop the IV infusion immediately the moment extravasation is suspected, but leave the IV needle in place — Stopping the infusion prevents more chemotherapy drug from leaking into the tissue and causing more cell death, but keeping the needle in lets us pull back (aspirate) the leaked drug before it spreads deeper
2. Aspirate 3 to 5 milliliters of fluid back through the IV needle using a small syringe before removing the needle — Pulling back removes some of the leaked chemotherapy drug from the tissue before it kills more cells, which reduces the size and depth of the wound that will form
3. Photograph the extravasation site and mark the borders of swelling or redness with a pen, then measure the area in centimeters — Pictures and measurements create a baseline to track whether tissue damage is spreading or shrinking over the next hours and days, which tells us if treatment is working or if we need surgical consultation
4. For anthracycline drugs like doxorubicin, notify the physician immediately to order dexrazoxane (an antidote) IV within 6 hours and apply cold packs for 15 to 20 minutes four times daily — Dexrazoxane blocks the chemical reaction that causes anthracyclines to kill tissue cells, but it only works if given within 6 hours, and cold packs slow down blood flow so the drug stays localized and causes less spreading damage

5. For vinca alkaloid drugs like vincristine or taxane drugs like paclitaxel, inject hyaluronidase (an enzyme) into the extravasation area and apply warm packs for 15 to 20 minutes four times daily — Hyaluronidase breaks down connective tissue and helps the leaked drug spread out and get absorbed faster instead of sitting in one spot killing cells, and warmth increases blood flow to wash the drug away
6. Elevate the affected arm above heart level on pillows — Gravity helps drain excess fluid out of the tissue through the lymph vessels (drainage channels), which reduces swelling, pain, and pressure that can cut off blood supply and cause more tissue death
7. Do not start another IV in the same arm, and document the exact drug name, volume extravasated, needle size, location, and all interventions in the medical record — The damaged tissue and veins need time to heal and starting another IV nearby risks more leaking, and detailed documentation creates a legal record and helps oncology teams track complications to improve IV safety protocols
8. Teach the patient to watch for increasing pain, blistering, skin breakdown, or fever and to call the oncology team immediately if any of these develop in the next 2 weeks — Tissue death from extravasation can take days to fully appear as the cells die slowly, and infection can set in when skin breaks down, so early detection of worsening damage allows for wound care or plastic surgery referral before permanent scarring or disability occurs

Sources

- Oncology Nursing Society (ONS) Chemotherapy and Immunotherapy Guidelines
- American Society of Clinical Oncology (ASCO)
- National Comprehensive Cancer Network (NCCN)
- European Oncology Nursing Society (EONS) Extravasation Guidelines

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