

CAVE RESCUE

A Handbook for the Everyday Heroes of the Deep

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History

The Hungarian Cave Rescue Service

Author: József Mészáros

History and Organization

The scientific exploration of Hungarian caves started more than 200 years ago. It developed rapidly in the first half of the twentieth century, spurred by the founding of the Hungarian Speleological Society (Magyar Karszt- és Barlangkutató Társulat) in 1910. Progressively more people went into the caves in the hope of discovering an unknown world. Rudimentary equipment and techniques, combined with the objective hazards (terrain and conditions) and subjective hazards (human factors), made accidents frequent — some of them fatal. At that time no cave rescue service existed, so injured explorers had to be rescued with primitive equipment and methods of the day.

Budapest, the capital of Hungary, stands out among the cities of the world: close to 200 caves lie beneath it, with a combined length of more than 89 kilometers (55 miles). The Buda Thermal Karst is recognized worldwide as a textbook example of hypogene karst, which is characterized by a maze-like network of passages. General interest in caves grew considerably after the Second World War, and more adventurous visitors sought out these difficult, labyrinthine caves — and frequently got lost in them.

The lost-caver callouts, occasional serious cave injuries and accidents, and above all the desire to save lives brought the Hungarian Cave Rescue Service (HCRS) into existence in 1961. Dr. György Dénes, later the president of the service, played a key role in creating the organization.



1. The logo of the Hungarian Cave Rescue Service (HCRS).



Dr. György Dénes (September 3, 1923 – April 30, 2015): lawyer, historian, geographer, scientific advisor and cave explorer; founder and lifetime honorary president of the Hungarian Cave Rescue Service, author of nearly 300 books and papers. Chair of the Cave Rescue Commission of the International Union of Speleology (UIS), and later its honorary chair for life. A devotee of caves and of cave exploration, Dénes was behind the founding of one of the defining speleological groups of the era, the Vörös Meteor Caving Group, and behind the exploration of Meteor Cave.

As a formally constituted body, the HCRS established official cooperation with the police, the fire service and the civil protection authority. It also developed a callout system and built up a cache of then-modern rescue equipment.

Regular exercises began. They trained members in evolving techniques, built experience, and — no less important in a real callout — forged a close-knit, well-drilled team. Operations grew steadily more professional. This developing foundation of expertise and capability determined how well, and how fast, the service could respond for years to come.



3. Rescue exercise on the surface in 1968. (Photo: Dániel Bajomi archive)



4. Practicing medical treatment in the 1970s. (Photo: Kinga Székely archive)

Most callouts still involved lost cavers, though serious injuries occurred too. Rescuing a caver with a severe head injury from Meteor Cave in 1969 was a





Cave Rescue Techniques

2

Technical Warm-Up

Author: József Mészáros

This chapter is meant as a gentle warm-up before the longer, more detailed chapters that set out the building blocks and the varieties of rope maneuvers.

This book is written for cavers who move confidently on rope, know the rules of SRT, understand their equipment and its limitations, and have years of practical caving behind them. It also assumes experience in rigging caves for trips: running the rope down a pitch from existing anchors to the standard required by SRT. That is a different skill from bolting a cave, which a later chapter covers in detail.

This warm-up chapter therefore does not give a complete picture of the rope maneuvers used in a rescue. It sets out only what a rescue adds to what you already do underground, and how familiar techniques change once a stretcher and a casualty are hanging on the rope.

Standards and Strength

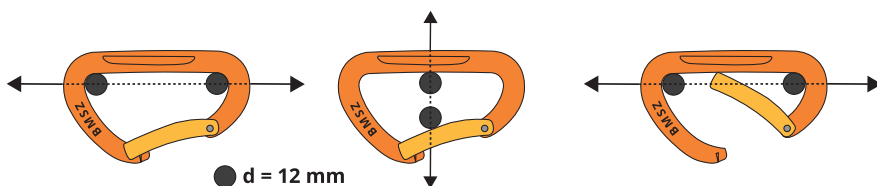
Most of the equipment used in cave rescue **conforms to the standards** for personal fall protection equipment *, which lay down requirements, test methods and the markings the manufacturer must apply. In Europe, equipment for caving and rock climbing may only be sold with CE (European Conformity) certification, which guarantees that the item has been tested, has passed quality control, and meets the requirements of the various applicable EN (European Standards) standards. Before EN standards existed, the UIAA — the International Climbing and Mountaineering Federation — introduced a standard and test system for checking climbing equipment, and it is still to be found on some items today. On a carabiner, for instance, the UIAA mark means that it meets UIAA 121¹, which adds a small number of extra requirements on top of EN 12275.

* PPE – Personal Protective Equipment / PFPE – Personal Fall Protection Equipment.

The **standards prescribe minimum strengths** for equipment in various loading cases. For a plain non-locking carabiner, for example, EN 12275 requires the following*:

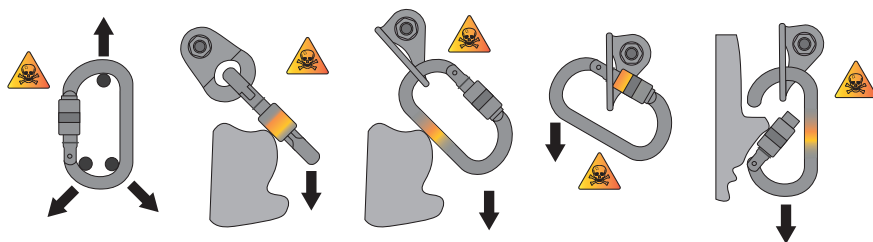
- Strength along the major axis: 20 kN.
- Strength along the minor axis: 7 kN.
- Strength along the major axis with the gate open: 7 kN.

A mass of one metric ton (2,200 lb) weighs roughly 10 kN (~ 9.81 kN, to be exact).



17. Testing a non-locking carabiner in different directions.

The strength values marked on the equipment — which in some cases exceed the figures the standards require — are known as the Minimum Breaking Strength (MBS); throughout this book you can read “strength” as meaning exactly that.



18. Dangerous loading directions, for which the strength is unknown.

What happens to an oval carabiner loaded in three directions at once? At what force does the intermediate carabiner break if its gate has caught on the hanger? How strong is a carabiner under the bending force that arises where it is pressed against the rock? Questions like these can only be answered by breaking things — by our own tests or somebody else’s — because the standards do not cover them.

So we cannot always speak of “the strength” of a piece of equipment, because there are many ways to load it. What is more, the strength of textile equipment — slings and ropes — can fall considerably over the years as the

* In the test the carabiner is pulled along its major and minor axis by two 12 mm steel bars, and it must hold the loads given above.

Rescue Building Blocks

Author: József Mészáros

The following chapters explain, step by step, the fundamental techniques used to rig and carry out even complex maneuvers.

Cave-rigging techniques are omitted because you should already know them thoroughly. Others, including haul systems, may be familiar from your training, but are worth revisiting from a cave rescuer's perspective. Before beginning, review the symbols used in Figures 46 and 47.



Correct, well-executed step or solution.



Solution to be avoided — dangerous or life-threatening.



Ropes used to move the stretcher;



Auxiliary rope.



Cave rescuer holding or gripping the rope, or actively lowering or hauling it.

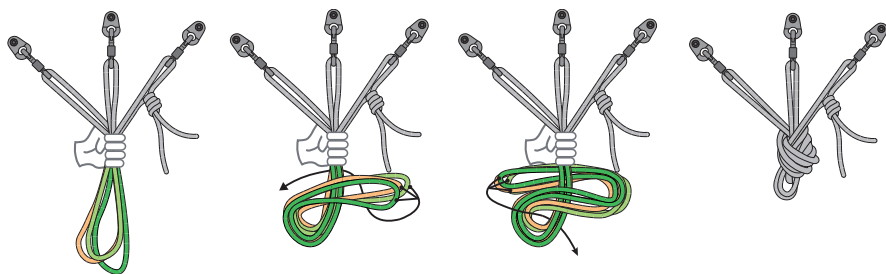


Stretcher or any other load.



Anchor built from two or three anchor points.

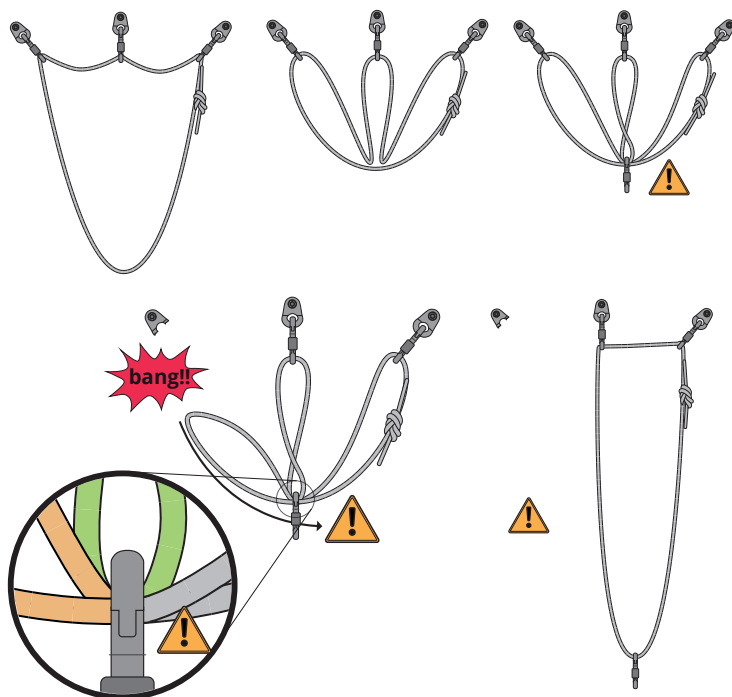
46. The symbols used.



51. Tying a load-sharing anchor.

There are several methods for tying the loop and equalizing the anchor points; everyone should use whichever suits them best. **But what matters more than that is that every cave rescuer must be able to examine a three-point equalization and decide whether it is right or not.**

Consider what happens when the three anchor points are badly equalized, as shown in the following figures, and the left-hand hanger and its carabiner break. The loop connected to that anchor can run freely through the master carabiner, causing a substantial fall that endangers both the casualty and the two remaining anchor points.



52. An anchor point failing on a badly equalized anchor.

Counterweight System

The stretcher is usually moved vertically by a counterweight haul, using a rescuer of roughly the same weight to do the lifting.

It is the most efficient method, and its advantages are:

- ▲ The **stretcher travels smoothly** and evenly, with no sudden jumps or jerks.
- ▲ It is the **fastest lifting method**, significantly faster and more efficient than a haul system.
- ▲ It needs **very little equipment** and is extremely simple to assemble.
- ▲ It takes only two cave rescuers to operate.
- ▲ It **works in both directions**, and reversing it is simple.

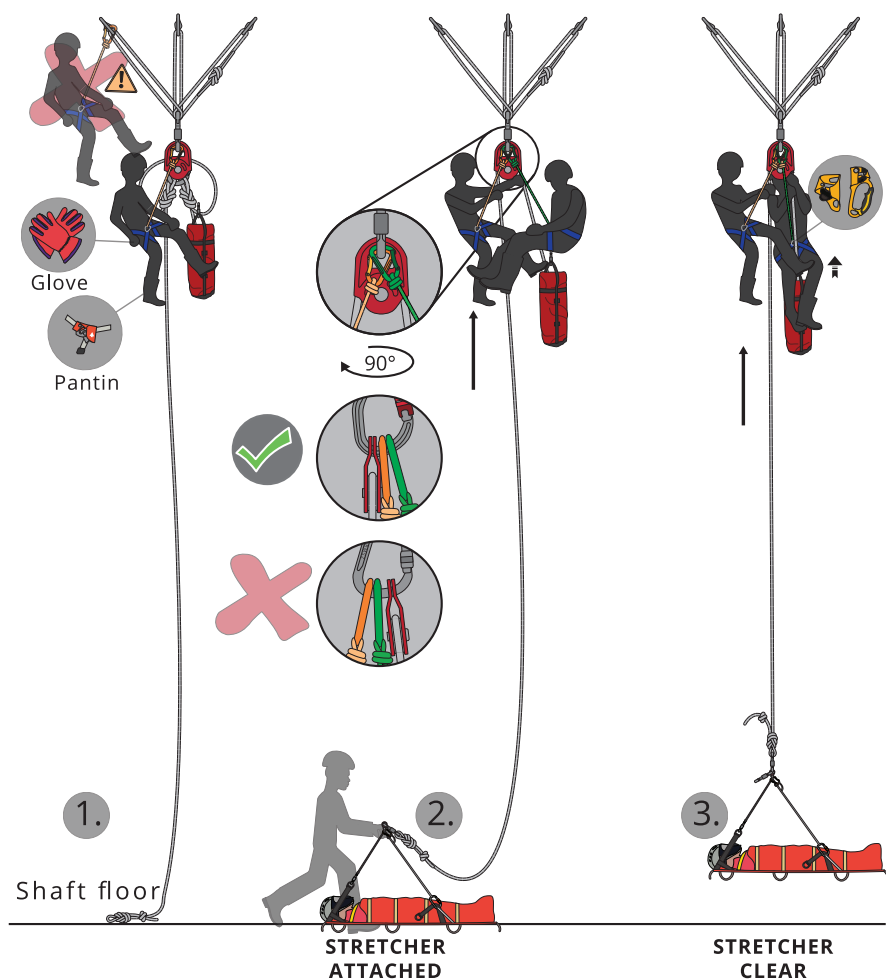
The drawbacks of the counterweight system:

- ▼ It requires constant attention and **remains vulnerable to human error**.
- ▼ The rescuers **need sufficient space to work**, so the method cannot be used in confined areas.
- ▼ In shafts with loose rock, a counterweight moving alongside the stretcher increases the risk of rockfall.
- ▼ The anchor points often **support three to five people**, placing greater loads on the equipment.

The counterweight system requires two cave rescuers: a counterweight and a controller (regulator). The counterweight is connected to the stretcher by a rope running through a rescue pulley. Since the counterweight and stretcher are of roughly equal weight, the counterweight's body weight provides the force needed to move the stretcher.

The counterweight is not simply a passive load. They must work in close coordination with the controller, since an error can drop the stretcher.

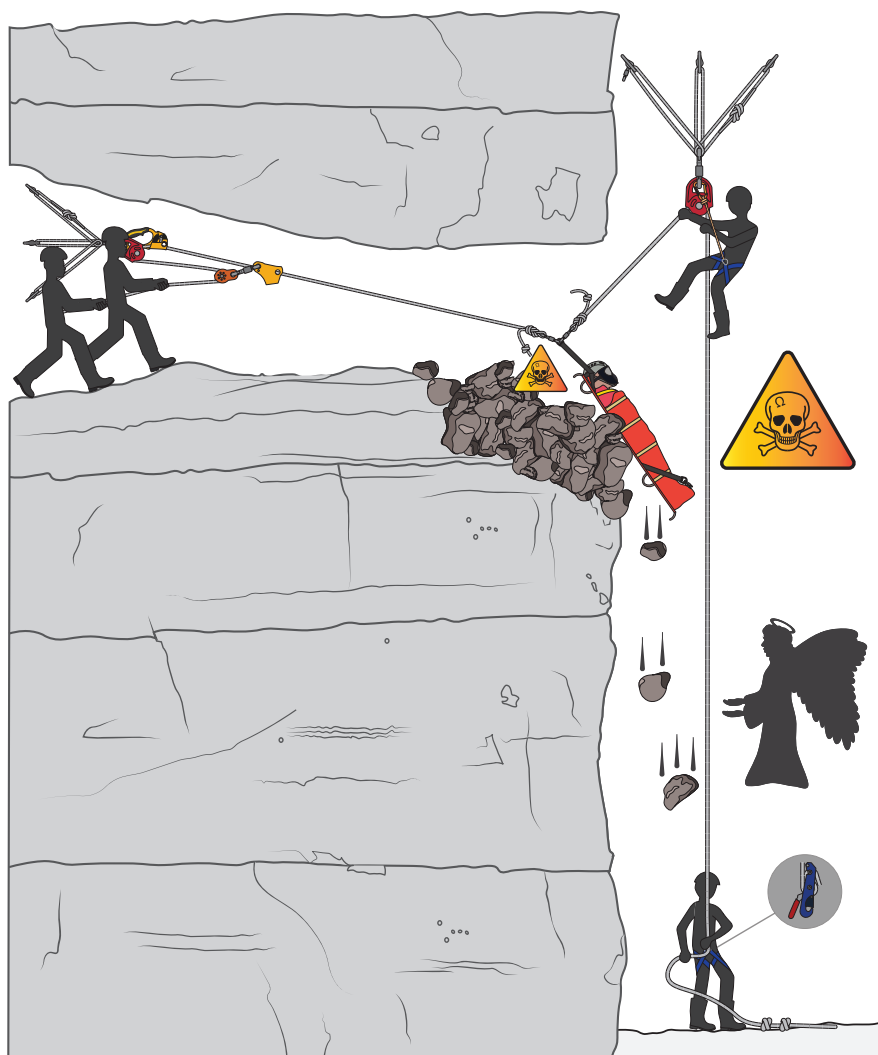
The controller has four jobs:



94. The opening steps of a counterweight haul.

3. The controller releases the two securing figure eight on a bight knots, pulls the rope taut, and instructs the counterweight to put their ascenders on the rope and start climbing *, cowstail still clipped in (Figure 94/3).
4. The stretcher's rope comes taut and the stretcher rises, watched and guided by the transport team. Once it is clear of the ground they signal: **STRETCHER CLEAR** (Figure 94/3).
5. The controller checks the system's balance, then squeezes the two strands together and signals the counterweight to unclip their cowstail (Figure 95/4).

* Despite those few meters of climbing, this method is still called the passive counterweight method.



120. In many cases the Z-rig shaft exit cannot be used.

The Preferred Method.

In the first method the controller raises the foot end of the stretcher with an extra auxiliary rope, helped by one cave rescuer. **This is the recommended method**, because it is simple, easy to follow and needs little equipment. Its only drawback is that the controller will most likely not be able to reach the foot end of the arriving stretcher to clip the auxiliary rope in — a job for the cave rescuer who is assisting with the maneuver anyway.

Bolting Caves for Rescue

Author: József Mészáros

Cave rescue presents unique challenges that demand sound knowledge and thorough preparation. Rescuers must be skilled not only in first aid and casualty care, but also in designing underground rope lines, selecting anchor points, and choosing suitable equipment. Poor planning or execution endangers both the team and the casualty, while **fast, competent rigging can save lives and time**. Every cave rescuer therefore needs strong theoretical and practical rigging skills to support a safe, efficient operation.

A cave rescuer must view a vertical cave differently from a recreational caver. On a sporting trip, the rigger follows existing bolts, keeps the rope clear of the rock, and divides long or complex pitches. During a rescue, the rigging team must also install additional anchors and build the rope systems needed to protect rescuers and move the stretcher.

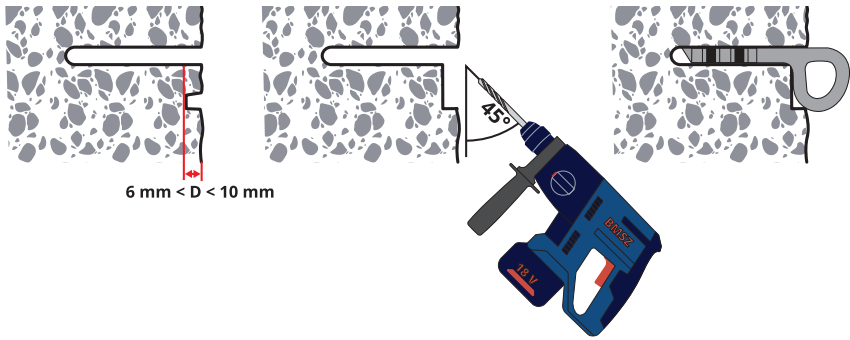
This chapter focuses on bolting techniques and assumes that the reader is an experienced rigger familiar with the standard caving-technique syllabus. First, however, a brief review.

Rock, Materials and Equipment

Rock

Even if geology is not your favorite subject, a basic understanding of rock properties is still essential for anyone on a bolting team. Even the best equipment is useless if the anchor fails the first time it is loaded. As the German Alpine Club's bolting guide puts it, **a bolt is only as strong as the rock in which it is placed**²².

What decides whether a bolt holds is the rock **strength**. The measure used throughout this chapter is the *uniaxial, or unconfined, compressive strength*: the load at which a cylinder of rock crushes in a press in megapascals ($1 \text{ MPa} \approx 10 \text{ kgf} / \text{cm}^2 \approx 145 \text{ psi}$). Manufacturers test bolts for certification in C50/60 concrete, that is 50 MPa ²³, and uncracked concrete behaves much like solid natural stone²².



157. Cutting the notch for the eye of the glue-in anchor with a thinner drill bit.

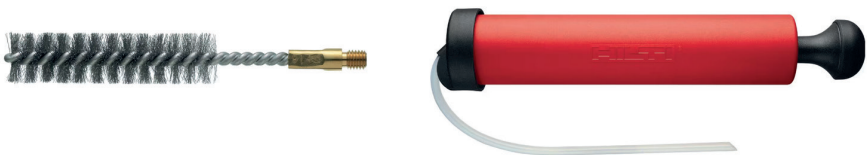
CLEANING THE HOLE

Hole cleaning is critical. Residual dust prevents the resin from bonding to the rock, leaving the anchor bonded only to loose debris and dust, which destroys its strength.



158. A glue-in anchor pulled out of a hole full of drilling dust.
(Source: Deutscher Alpenverein e.V.: Bolts, 2nd edition, 2025)

1. **Brush the hole** with a borehole-cleaning brush. In soft rock such as sandstone, use a plastic rather than a wire brush.
2. **Blow out the dust** with a pump or dedicated blow tool; a silicone tube alone is insufficient.
3. **Repeat** the brushing and blowing **cycle three or four times**.
4. In highly porous rock, flush dust from the pores with water only if the resin is approved for wet holes.

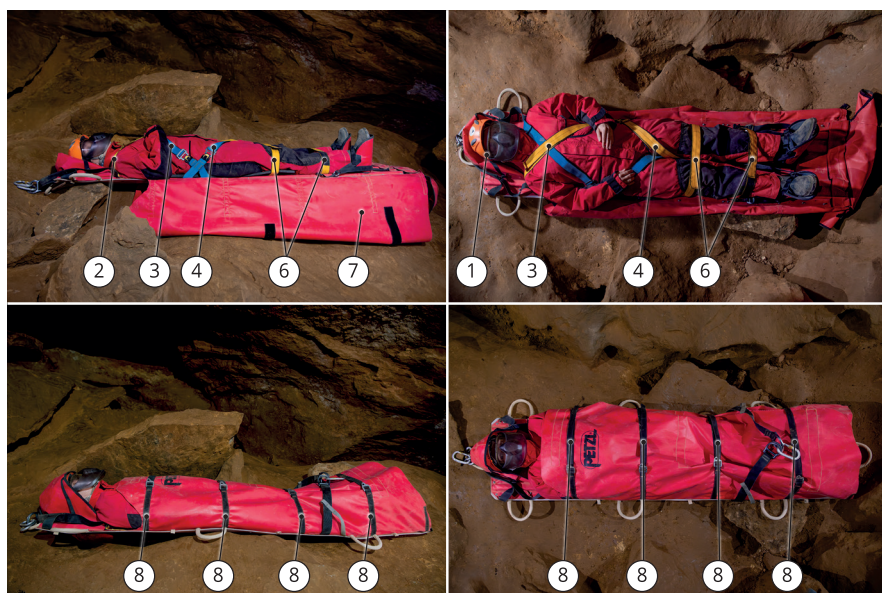


159. A hole-cleaning brush and pump. (Source: hilti.hu © Hilti Corporation)

The packaging sequence is presented as a numbered list. Steps that protect and secure the casualty are numbered separately and shown in Figure 172, with selected steps also illustrated in close-up photos.

The Packaging Process:

1. Prepare the stretcher for packaging: find a stable spot for it (next to the casualty if possible), unthread the straps, fold the covers and flaps out to the sides and lay the body harness aside as well, so that the casualty only has to be placed onto it.



172. The steps of packaging. (Photo: Márton Kovács)

2. Remove any unnecessary equipment from the casualty (vertical gear, helmet).
3. Unless the doctor orders otherwise, always provide hypothermia protection using bubble wrap, a Blizzard blanket or a rescue sleeping bag. On short cave rescues or summer surface rescues this is usually unnecessary.
4. Fit the face protection and the dedicated helmet (step 1: 172/1).
5. Position the casualty on the stretcher so that their shoulders line up with the top of the torso straps (step 2: 172/2). Getting the casualty's position right is critical to the whole packaging process and deserves particular attention.
6. Using the body harness, secure the torso strap first (step 3: 172/3), then the pelvis strap (step 4: 172/4) — watch the matching colors! Pull the

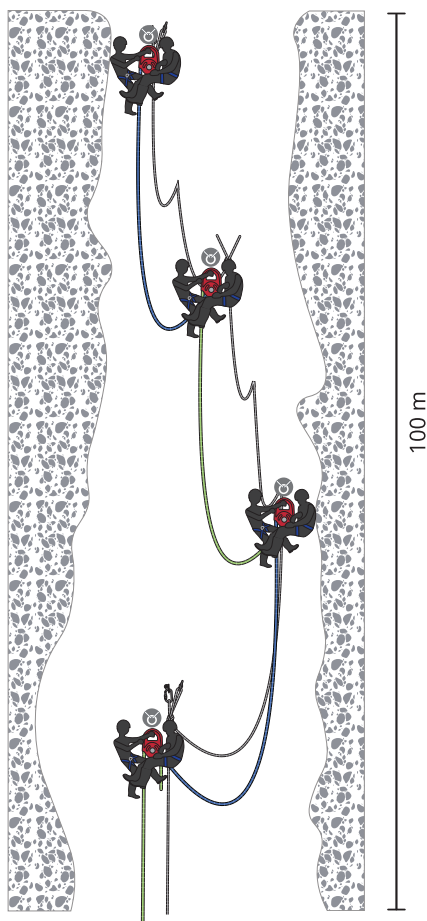
Transport in Vertical Terrain

The term vertical terrain includes shafts and sections that are climbable but too steep or difficult for the stretcher to be passed safely by hand, requiring rope transport instead. These may include steep slopes or easily climbed rock steps. A dedicated rigging team usually plans, rigs, and ideally operates the required rope systems. In caves with many such sections, the team may not be present when the stretcher reaches a particular spot; the transport team leader must then interpret the rigging plan and direct the stretcher movement accordingly.

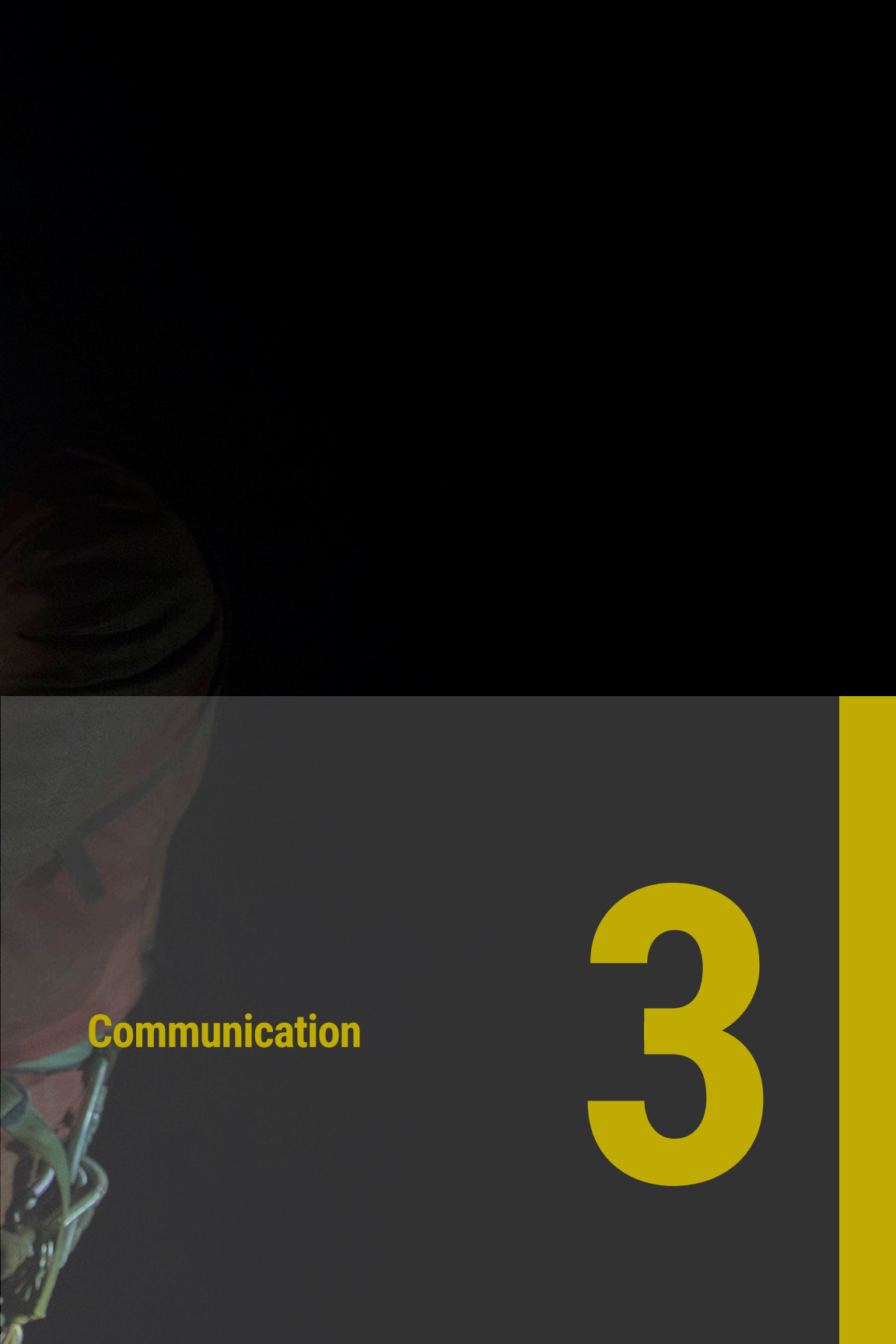
Team Deployment Models

The logistics and organization of the teams matter at least as much as the various stretcher transport techniques: mishandling human resources and equipment can slow a rescue operation down badly, or even make it fail. In this section we present several team deployment models, to be chosen according to the complexity and depth of the cave.

Hungary and most other European countries have adopted the French cave rescue system with minor modifications; beyond the individual rescue techniques, it also lays down organizational principles. A rescue calls for the coordinated work of several teams with dedicated tasks — rigging, transport, communications and so on — each led by a highly skilled team leader who is responsible for a given section of the cave under the instructions of the incident commander. On reaching a series of pitches, the aim, always in the casualty's interest, is fast, uninterrupted transport that keeps the time the stretcher spends hanging in the air to a minimum. Transport only begins once the rescue lines have been rigged in every single shaft and every cave rescuer operating them is in position, waiting for the stretcher to arrive. The French concept is extremely comfortable for



194. The French concept illustrated in a shaft.



Communication

3



218. A μ HeyPhone, the surface-mount rebuild of John Hey's original design.
(Photo: Ian Cooper)

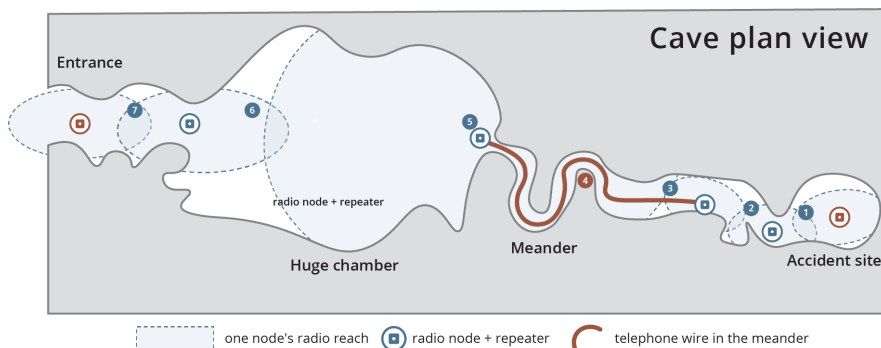
Handheld Radios Underground

A standard PMR handheld cannot transmit through rock, but it can work across open underground spaces. It is useful in a large chamber or shaft when stations are within sight but too far apart to shout. In practice, however, handheld radios are used most often at surface rescue demonstrations.

Mesh Radio Systems

How a Mesh Network Works

Mesh systems avoid transmitting through rock by relaying signals along cave passages.



219. How a cave mesh network works. Each node relays messages to neighboring nodes, allowing them to hop from the accident site to the surface. Where radio signals cannot pass, two nodes can be linked by cable.

The principle is simple: teams place small, battery-powered radio nodes along the route, close enough for each to communicate with its neighbors. Every node also acts as a repeater, passing messages from one node to the next until they reach the surface, while the network determines the route automatically. No advance survey or cable installation is required; the team simply deploys nodes as it proceeds.

The background of the page is a dark, atmospheric photograph of a cave interior. The left side shows rugged, brownish rock formations, while the right side is mostly black, suggesting a deep, unlit passage. A large, bright green number '4' is positioned on the right side, partially overlapping a solid green vertical bar that runs down the entire right edge of the page.

The Cave Rescue Operation

4

The Course of a Cave Rescue

Author: András Hegedűs

Cave rescue is a complex process made up of many operational sequences, including those described in the previous chapters. **This chapter examines this process as a whole.** Because many factors shape its course, even a second rescue at the same site may unfold very differently.

A rescue is organized through continuous decision-making and coordination of the resulting tasks. The incident commander and other officers direct this work within a strict hierarchy. The operation depends heavily on the casualty's injury and condition, changing hazards such as flooding, poor ventilation, or carbon dioxide buildup, and the material, technical, and human resources available.

Because no two rescues are alike — even the same people may arrive in a different order — every operation requires equally rigorous organization and command.

Everyone involved must use resources carefully and efficiently. Protect the equipment, use only what is necessary, and avoid waste.

This chapter focuses on the system used in Hungary, which closely follows principles established elsewhere in Europe. Countries may differ in the number of organizational levels and the titles of individual officers, but the core principle is the same: every rescue must have an overall leader, and each independently operating team responsible for rigging, casualty care, or transport must have its own designated leader. Leaders are accountable for decisions at their level and for ensuring that instructions from above are carried out below.

Core Rules for Cave Rescue

1. **The casualty's welfare comes first.** Every decision must support that priority.
2. **The principle of maximum safety throughout the rescue.** Organize and conduct the operation to minimize additional accidents and prevent any worsening of the casualty's condition. Use the best available equipment,*

* Do not use personal equipment in a cave rescue (e.g. a sling)!

assign the most capable rescuers to critical tasks, and bring in additional resources when needed. Less experienced members should receive duties suited to their skills or work alongside highly qualified rescuers; exercises are the appropriate setting for newcomers to practice every role.

3. **The incident commander directs the operation.** On larger rescues, deputy incident commanders may assist. Appointed team leaders direct their rescuers, either personally or through section leaders. Everyone must follow their instructions; operational decisions are not debated during the rescue but reviewed afterward. The incident commander is accountable for the overall operation, team leaders for their assigned areas, and rescuers for any independent action taken when no instructions are available.
4. **In an accident involving injury, the first and most important thing is to get the doctor and the medical equipment to the scene.** If a doctor is not immediately available, send a trained medical professional or the most experienced first-aider.
5. Based on the doctor's assessment and the casualty's condition, **the incident commander and team leaders decide how the casualty will be transported** and when movement will begin, pause, or resume.

Grading of Cave Rescue Operations

Rescue operations are graded by factors such as the casualty's condition, cave characteristics, distance from the entrance, terrain, expected duration, and required resources. Because operations of different complexity need different procedures, each country uses a classification suited to its caves and circumstances, although the underlying principles are broadly similar.



222. The five grades of cave rescue.

Initial casualty care and operational support (ICCOS) covers the immediate care provided by the cave rescue service's medical first-responder team, the personnel required — including the service's doctor or paramedic, or an external clinician in an emergency — and the technical support needed, such as urgently establishing cave communications. Where a service has a paramedic

Medical Care during Cave Rescue

Author: Dr. Dénes Ákos Nagy

Medical care plays a crucial role during cave rescues, as the casualty's survival and the prevention of further deterioration depend on rapid and professional intervention. In the underground environment, the response to an accident can often take hours or even days, so it is vital to ensure proper first aid and continuous care. Medical assistance provided in the cave not only serves to save the casualty but also contributes to the success of the entire rescue process; therefore, all participants must be familiar with basic care procedures.



236. Medical care — practice. (Photo: Márton Kovács)

The goal of our work is to ensure the long-term survival of a casualty who is unable to move independently. We achieve this goal through the coordinated efforts of a large number of responders; we refer to this entire process as the chain of survival. However, it is true that the chain is only as strong as its weakest link. The goal of general and cave medical training, as well as this chapter, is to strengthen these links.

The first element in the chain of survival is **first aid**. In the event of a caving accident, hours — or even days in the case of an international expedition — may pass before emergency services arrive.

Communication: No one should touch the patient during the handover!
 More than an hour has passed since the accident; there's no need to rush. Make it clear who is handing over and who is taking over. No one else should speak! Let the first responder summarize what happened in their own words:

- What happened? How did the accident occur?
- What was the patient's initial condition?
- How did the patient's condition change over time?
- What injuries do we know about?
- What treatment has been provided?

After the first responder's summary, ask our specific questions.

The acronym MIST can be helpful when summarizing the patient handover:

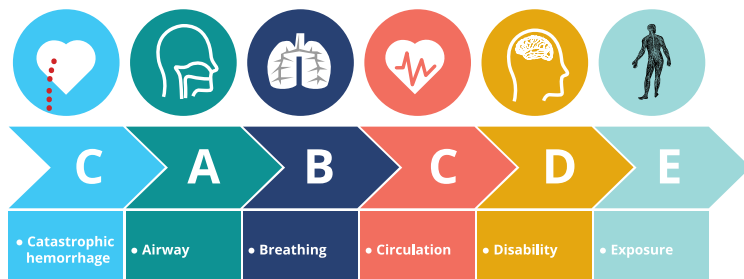
M	Mechanism
I	Injuries
S	Signs
T	Treatment

Table 7. The MIST scheme for the patient handover.

Patient Examination

The purpose of the patient examination is to gather information; primarily for ourselves, and secondarily for the other participants in the chain of survival.

- If the scene **is not suitable** for treatment, conduct a quick, focused assessment to answer your specific questions (primarily regarding how the patient can/should be moved).
- If the site **is suitable** for treatment, conduct a detailed patient examination.



239. Rapid assessment — (C)ABCDE assessment / Primary survey.

Movement without the use of splints

Protecting the cervical spine is a top priority. The main reason for this is that the nerves responsible for breathing exit the spinal canal approximately in the middle of the neck, and it would be suboptimal if the patient were to lose this function. There should always be someone dedicated to immobilizing the neck (see MILS figure); this person will also be the one directing the patient's movement.



240. Neck immobilization using the MILS technique. (Photo: Márton Kovács)

After this, we have several options for moving the casualty.

- If the casualty does not need to be relocated and you only want to slide thermal protection underneath them, the preferred technique is the “log roll.”
- Two additional rescuers position themselves on one side of the casualty, at the chest and hip. Grasping the casualty's shoulder, side, hip, and leg, they can rotate them around their axis in one smooth motion, “like a log.” If the rescuers overlap their hands, it helps synchronize the movement (see Figure 241).

If the casualty needs to be moved:

- The caving suit (coverall) provides excellent support for the patient and offers adequate grip points. If at least one helper holds the coverall at the chest and another at the groin, the patient can generally be moved with

Glossary

The technical terms of this book, in the sense in which the book uses them. Cave rescue terminology is not uniform — the same device or maneuver often has a different name in France, Italy, Britain and North America — so where the book has deliberately chosen one term over another, the entry says so. Cross-references are in *italics*.

A

A2, A4 — Stainless steel grades. A2 (AISI 304L) is ordinary stainless; A4 (AISI 316L) contains molybdenum and resists acidic cave water far better. Use A4 for permanent placements.

(C)ABCDE — The primary survey: a tool-free assessment of about a minute that checks catastrophic bleeding, then airway, breathing, circulation, disability and exposure, so that nothing immediately life-threatening is missed.

accessory cord — Cord of small diameter, 5–6 mm and up; 4–5 m of it travels with the stretcher. Also called prusik cord, after the *friction hitches* tied from it.

active counterweight — See *counterweight*.

aid climbing — Climbing on placed equipment (*anchor* point) rather than on the rock, used to reach a bolt placement or to climb an *aven*.

anchor — A solid, secure point used to attach a rope or an equipment to the cave rock. It could be artificial (bolt) anchor metal fixtures placed permanently or temporarily into drilled holes in the cave rock or natural anchors utilizing cave environment (e.g. stalagmite). Special form is the *human anchor*. One point is an *anchor point*; several combined make an anchor system.

anchor loop — The rope loop that ties a multi-point anchor together and carries the *master carabiner*. EN 1891 Type A rope, closed with a *bend*.

anchor point — A single point of attachment: a *bolt* or a *natural anchor*. See *anchor*.

anchor system — See *anchor*.

ascender — A *rope clamp* carried as personal equipment for climbing a rope, usually a hand ascender with a handle or a chest ascender.

attending counterweight — See *counterweight*.

auxiliary rope — Any secondary rope rigged for a particular task, as opposed to the *rescue line*.

aven — A shaft rising from a passage roof, climbed from below rather than descended.

B

backup rope — The stretcher's second, redundant rope on a rope system, independent of the *rescue line*. Not to be confused with *safety rope* or *progression line*: each protects something different.

base plate — See *basket stretcher*.

basket stretcher — Rigid-shelled stretcher enclosing the casualty, the standard form for rope rescue on the surface.

bend — A knot joining two rope ends. See *figure eight bend*, *offset bend*. A bend is used to create an *anchor loop*.

board stretcher — A flat, rigid board with handholds: a medical spinal device pressed into rescue service for special applications. See *spinal board*.

body harness — The stretcher's own strap system holding the casualty in: torso and pelvis straps, leg straps, foot support straps and stirrup.

bolt — Any drilled anchor point — *self-drilling anchor*, *expansion bolt*, *concrete screw* or *glue-in anchor* — together with the *hanger* or *ring* clipped to it.

bolting — Placing bolts. Hand bolting is bolting without a power drill.

bowline on a bight — Non-redundant double-loop knot for attaching the rope to two anchor points.

braking carabiner — A carabiner adding friction to a *descender*, for a normal, wet or muddy rope. Never clipped into the *master carabiner* itself.

C

callout — The alerting of the service and its members; a live callout is a real one, not an exercise or a standby.

callout coordinator — The officer who takes the emergency call and organizes the rescue until command is established.

cam — The toothed, sprung jaw of a *rope clamp* or of a pulley with progress capture.

casualty — The person the rescue is mounted for. The book says casualty rather than patient outside the medical chapter, because cave rescuers move people who are not necessarily under treatment.