Instructor Guide

Reducing Earthquake Risk in Hospitals

from Equipment, Contents, Architectural Elements and Building Utility Systems

A Short Course for Doctors

GeoHazards International
A Nonprofit Working Toward Global Earthquake Safety

GeoHazards Society
INDIA

Swiss Re

Instructor Guide

Reducing Earthquake Risk

from Equipment, Contents, Architectural Elements and Building Utility Systems

A Short Course for Doctors

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The course was developed by Janise Rodgers, Hari Kumar, and L. Thomas Tobin. The authors express their gratitude to the following technical reviewers:

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Contents

Purpose

Hospitals provide life-saving medical care on a daily basis to the communities that they serve. Communities expect the hospital staff to save lives in an emergency and to care for community members that have been severely injured or have become seriously ill. Earthquakes threaten your hospital's ability to carry out its responsibilities to care for the ill and injured. Past earthquakes around the world have destroyed hospitals or damaged them so that they could not function. These hospitals failed their communities in their hour of greatest need.

Reasonable measures can reduce the risk of earthquake damage and losses, and to keep hospitals functioning after an earthquake. This short sensitisation course will help you educate doctors about the need to reduce one of the major sources of earthquake-related damage and losses: a hospital's medical equipment and supplies, contents, architectural elements, and building utility systems. Damage to these items has caused deaths, injuries, building functional loss, and economic loss in past earthquakes, even in cases in which the building structure itself was essentially undamaged. The course also provides an introduction to the other components necessary for keeping a hospital functional and safe: structural safety of hospital buildings, hospital emergency preparedness, and personal preparedness for the staff.

This set of sensitisation materials provides content and instructions for a short course for medical doctors. These materials are based on GeoHazards International's manual entitled *Reducing Earthquake Risk in Hospitals from Equipment, Contents, Architectural Elements and Building Utility Systems*, and are meant to be used in conjunction with the manual. Each participant should receive a copy of the manual, either electronically or in hard copy. The manual is freely downloadable from the GeoHazards International website: http://www.geohaz.org/hospitalsafetymanual.

GeoHazards International prepared this set of sensitisation materials for use in a hospital earthquake preparedness project in India, but the materials can be easily modified for use by other organizations in other locations with GeoHazards International's prior permission. The materials include this instructor guide, presentations in Microsoft Powerpoint™, and student handouts. This instructor guide will take you through the presentation slide by slide and will identify important aspects you should highlight.

Audience

Your audience will consist of medical doctors. Some will have administrative responsibilities as well.

Training Objectives

Our objective is that doctors should be able to do the following after they complete the course:

1. Understand why earthquake safety is important:

   (a) Understand why hospitals need to function and continue to care for patients after an earthquake, and not just avoid collapse of the hospital's buildings;
   (b) Understand what might happen to the hospital and its equipment, systems, architectural elements and contents if a strong earthquake occurred; and
   (c) Understand the basics of earthquake hazard in the region (i.e., that earthquakes can affect their location, historical earthquakes that occurred in the area, etc.).

2. Understand the basics of how to reduce the damage and consequences caused by an earthquake:

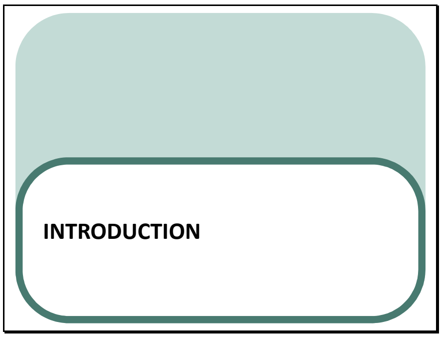
(a) Know the basic elements of a hospital earthquake risk management program: risk assessment, building safety, securing objects and systems, preparedness planning and training/ practice;
(b) Recognize and understand, conceptually, how to anchor or relocate items than can fall, slide, or topple and break, interrupt life support, cause injury or block exits;
(c) Know the basics of the hospital emergency planning process; and
(d) Know what to do before, during, and after an earthquake.

3. Understand how they can participate in earthquake safety efforts:

(a) Know the options for their involvement: join safety committee, identify and anchor hazards, develop solutions, etc.
(b) Think about their potential role in the hospital's emergency preparedness plan; and
(c) Develop a family preparedness plan.

Step-by-step Presentation Guide

Introduce GHI, GHS and Swiss Re with a few sentences about each. Introduce yourself and welcome your audience.



Tell the story of a hospital rendered non-functional by an earthquake. Use this slide with the story of Bhuj Civil Hospital in the manual, or tell a more recent story from another earthquake, such as Haiti or Chile. If you use a different story, replace this slide with a single slide with one or two photos of the hospital that emphasize the main points of the story.

Use the story to review some basic concepts about disasters – most people will know something about disasters just from watching the news –that disasters are either natural or human-caused events that cause damage and injure or kill people to the extent that that those affected need help to recover. There are many types of natural disasters (floods, cyclones, landslides, tsunamis, droughts, etc.), but we will focus on earthquakes today. It is very important to prepare ahead of time for earthquakes, because they strike without warning – there is no time to evacuate.

If you talk about Bhuj, you can ask – was the surgeon a hero? Yes, but he should never have had to be one. The building and its systems failed him, and we want to prevent that from happening to other doctors in other hospitals. He did what he could under the circumstances, but imagine what could have happened if the hospital building was functional. How many lives could have been saved? Infections and complications prevented?

Invite the participants to start thinking about what could happen in their hospital and how they can help make the hospital more resilient. Introduce them to the concept of resilience - that you plan to get back to normal operations (or as close as you can) within a certain timeframe after the disaster, which for hospitals will be as soon as you can.

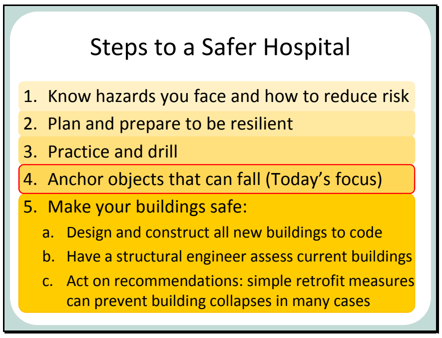
For instance, you would want to rebound to deliver critical services within a pre-determined number of days, not months. In the meantime, you plan to be able to deliver the appropriate level of care, which may be austere care if you have a mass casualty situation like in Bhuj, and your hospital building is not usable. Austere care is defined as the level of medical care, modified from the expected standard of care, which is provided when hospital resources, medical supplies and medical personnel are limited or unavailable for an extended response period. (For example, that might happen if the earthquake occurred tomorrow, before you had the chance to make any safety improvements.)

Earthquake damage affects unprepared hospitals more severely than other buildings because:

-Patients may incapacitated and therefore more vulnerable: many can't take protective actions that healthy people can; some are on life support; damage that would cause minor injuries to or merely inconvenience healthy people could severely injure incapacitated patients. Loss of a sterile or sanitary environment due to earthquake damage and functional loss can have drastic effects on the health of patients already vulnerable to infection.

- Hospitals have complex systems crucial to maintaining patient care: medical gases, electricity, climate control, suction/vacuum, water, electrical, communications; these systems can also create hazards when damaged by an earthquake: flammable gases, spilled laboratory chemicals and medicines, broken glass, fallen suspended ceiling panels (common in rooms with climate control) and dust creating unsanitary conditions

-Hospitals contain expensive medical equipment: it can be very costly and time-consuming to replace.



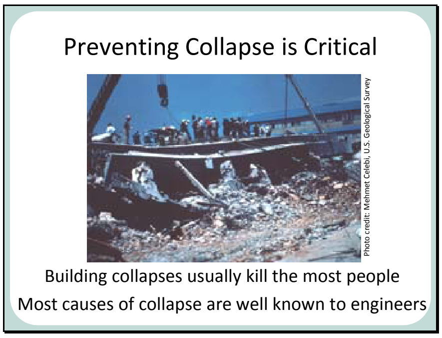
Explain that making a hospital safer and more resilient is a process that takes time. The process can be divided into a series of steps:

- Know which hazards you face – earthquakes, floods, fires, landslides and a number of other hazards could affect you. The Vulnerability Atlas of India (available from BMTPC), your State Disaster Management Authority, or GHS can help you determine which hazards could affect your hospital. Also, learn about what you can do to reduce your risk by attending training like you're doing today, or reading up on ways to reduce risk.
- Plan and prepare – your hospital will need to make plans for what to do if various potential disasters happen. We recommend that you start by forming a representative committee of people interested in safety, who will then

make plans and help implement them. You will also need to prepare by training staff, having supplies on hand, and making sure families of staff are prepared to manage without them.

- You need to practice your plan to make it better and so that everyone will know what they should do.
- Anchor objects that can fall, topple or slide during and earthquake and injure or kill people or disrupt important services. This step will be today's focus.
- The final step is making sure your hospital's buildings are safe: that they won't collapse during an earthquake and kill people. We have this as the final step not because it is less important but because it takes more time and greater expenditures. Preventing building collapses is actually the most important way to keep the hospital's staff and patients safe during and earthquake. There are three simple steps your hospital can take to prevent any of the hospital's buildings from collapsing. The first step is to ensure that all new buildings on the hospital campus are designed and constructed in accordance with India's building code for earthquake-resistant design, Indian Standard 1893, put out by the Bureau of Indian Standards. A knowledgeable structural engineer should do the design. Second, have a structural engineer with experience in the earthquake vulnerability assessment of buildings evaluate your hospital's buildings unless they were recently built to comply with the 2002 version of the IS 1893 building code – this is the first step to improve the safety of your current buildings. The third step is to act on the engineer's recommendations. In many cases, simple retrofit measures can prevent collapse.

You can and should advocate for all these things and support your administrators as they pursue structural safety. However, structural assessments and designs require a qualified structural engineer and may require larger expenditures. Today we are going to talk about what you can do meanwhile to reduce risks and improve the hospital’s ability to remain functional, especially in more frequent smaller earthquakes. Or, if your building is already earthquake-resistant, how you can greatly improve the chances that the hospital will remain functional.

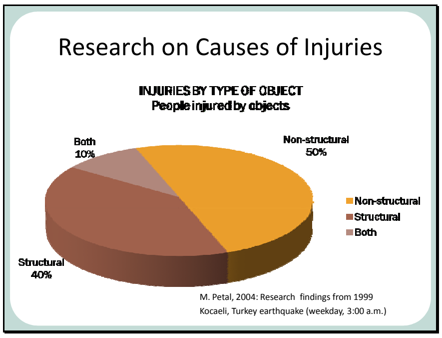


This hospital building was one of two that collapsed during the 1985 Mexico City earthquake. Explain that preventing the hospital buildings from collapsing is the first and most important way to save lives. In most earthquakes, building collapses cause the vast majority of deaths. (The most notable exceptions are large undersea earthquakes that generate tsunamis, such as the 2004 Sumatra, Indonesia earthquake that generated a tsunami that affected the whole Indian Ocean including India.)

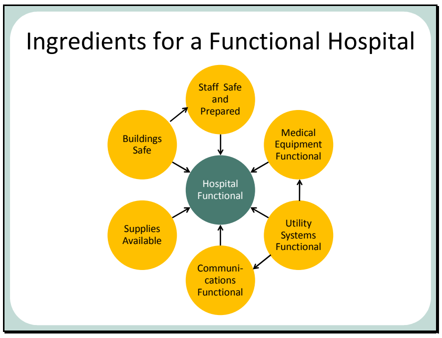
Preventing collapse should be your hospital’s top priority, though it may take time and funding. There are a lot of things you can do in the meantime to make your hospital safer and more likely to be functional, but we’ll get to that in a minute. The good news is that the types of severe damage that leads to collapse don’t have to happen. Almost all building collapses are caused by the types of deficiencies in the building’s design, construction, or maintenance that are well-known to structural engineers.

You may ask – why not just make the buildings safer and skip all the other steps? Earthquake safety isn’t just about the building standing up. This is a photo of the inside of a hospital in Chile after the 2010 earthquake. Ask participants whether they could work in this building. Why or why not? The power is out so it is dark, and light fixtures have fallen so even if there was power there would not be light. The suspended ceiling has collapsed, dropping accumulated dust on everything and leaving the corridor littered with debris. Objects are hanging from the ceiling.

Emphasize the importance of simple, often inexpensive actions that maintenance personnel can take. Over time, such actions can make a big difference. Example: anchoring cupboards to prevent exits from being blocked, putting snubbers on the emergency generators. The photos show how easy it can be to take steps toward safety.

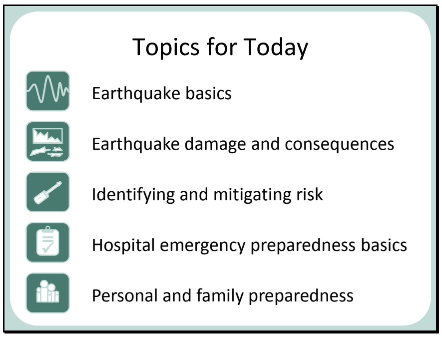


A survey of people following the 1999 Kocaeli (Izmit) Turkey earthquake showed that many people – fifty percent – were injured by non-structural objects. Securing or relocating these objects can prevent many injuries and reduce the demands placed on the health system immediately after the earthquake.

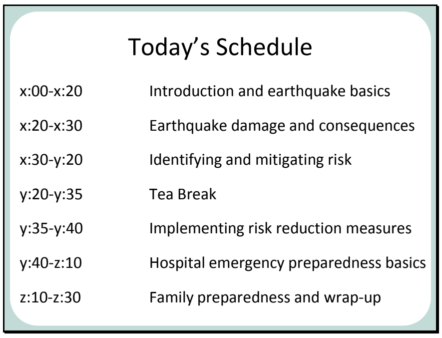


Explain that keeping a hospital functional after an earthquake requires a number of interdependent actions. Keeping the buildings safe will help keep the staff safe, so that they are available to provide lifesaving care to the community. In order to keep medical equipment functional, the equipment must not be damaged, and the utilities that power it must be functioning as well. For example, a ventilator will need both backup emergency power and the medical gas system to remain functional. An autoclave will require both electrical power and water. You will need building utilities functioning in order to provide services.

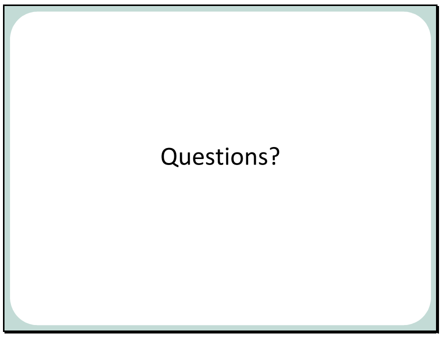
Take the time to discuss each of the items in yellow circles to help trainees understand how each item contributes to hospital functionality.



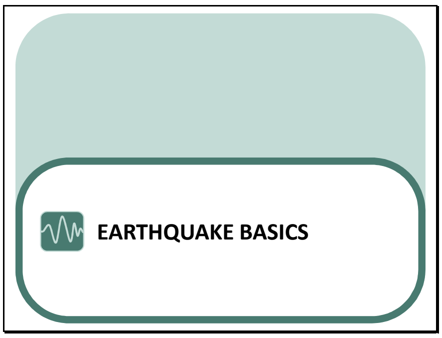
Introduce the topics we will cover during the course: earthquake basics, earthquake damage and consequences, identifying and mitigating risk, hospital emergency preparedness basics, and personal and family preparedness.



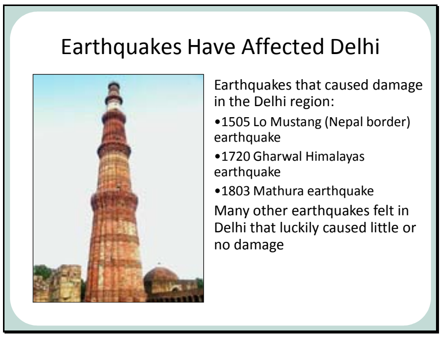
Go over the schedule. This is a suggested schedule. You can modify the start and end times and the length of the break as needed.



Answer any questions on the schedule before you begin with the first technical section, which is on earthquake basics.



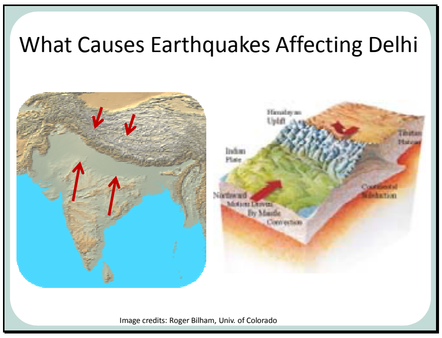
Earthquake Basics – in this section we will cover some basics of earthquake shaking.



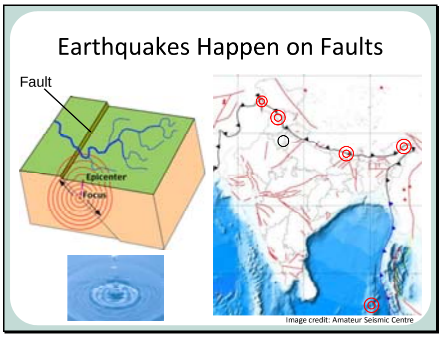
The earthquake hazard information in this slide and the next 3 slides is specific to Delhi. You will need to substitute hazard and historical earthquake information for the location of your training session. If you are in an area that had a major historical earthquake, add a slide for that earthquake that summarizes its effects: deaths, injuries, number of people homeless to the extent known. If you can find a relevant first-hand account of that earthquake, tell it briefly (1-2 minutes) to help the audience start thinking about what happens during earthquakes.

You can also ask the audience if they have felt earthquakes. You will need to keep an eye on the time, so call on only two or three people that said they felt and earthquake and ask which earthquake and how it felt. Try to keep them to less than a minute each, unless someone was working in a hospital when there was an earthquake that caused strong shaking at the hospital – that will be an interesting story that is worth taking time for! Part of the job will be convincing people that earthquakes can happen to them, and if someone in the room did have it happen to them, it can be very compelling. (If you do have someone like this with experience in a hospital in a major earthquake, please be sure to talk to them at the coffee break to get additional information from them, and determine how you might weave their experience into other parts of the training session.)

Some details on earthquakes affecting Delhi:
1505 Lo Mustang earthquake damaged Agra, Delhi, Dholpur and Gwailor. It was a very large earthquake.
1720 Gharwal Himalayas earthquake damaged Old Delhi
1803 Mathura earthquake was the last damaging earthquake to strike Dellhi - damaged the Qutub Minar

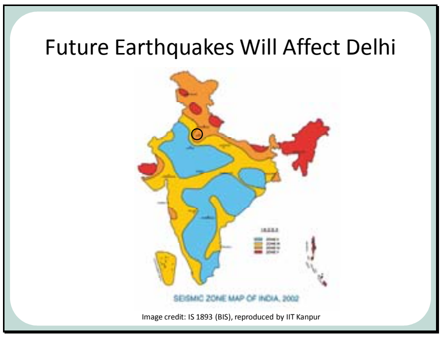


The portion of the earth's crust that India sits on, called the Indian tectonic plate, is colliding with the portion of the earth's crust that China sits on, called the Eurasian plate, as the graphic at left shows (ask if they remember plate tectonics from their school days). The Indian plate is actually going underneath the Eurasian plate. Tremendous forces are involved in this activity. This process has built (and is still building) the Himalayas, and it causes many earthquakes not only in the Himalayas but also near Delhi and in peninsular India as the Indian plate buckles and bends under the stress. This process has been going on for millions of years, and will continue for millions more, so future earthquakes are inevitable.

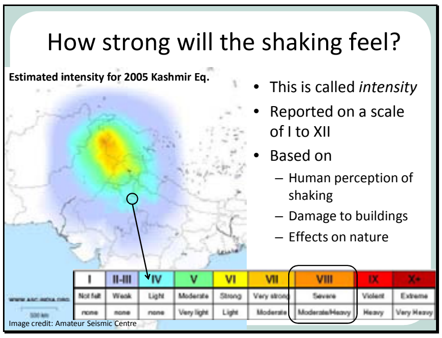


Earthquakes happen when the rocks that are locked together are unable to take any more deformation, and they break and slip past each other. This releases a huge amount of energy, some of which races through the earth as *seismic waves*, similar to the way ripples go out when you throw a rock into a pond. When the seismic waves reach the surface of the earth, we feel them as an earthquake. Next, explain that earthquakes occur on *faults*, which are weak places where the earth's crust has broken before. The big fault zone where the two plates come together is shown in black with triangles that point in the direction India is moving. Other major faults in India are shown in red on the map. If you know where the faults are, you know where earthquakes are likely to happen. And of course, there are faults near Delhi – point out the big black line with the triangles, and the smaller red line on the figure at right.

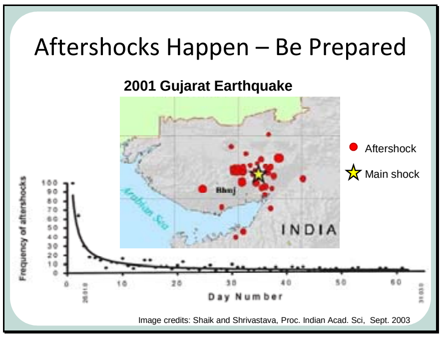
In the last 200 years, there have been several very large earthquakes along the main faultline that separates India from Tibet. From west to east, these earthquakes are the 2005 Kashmir earthquake, the 1905 Kangra earthquake, the 1934 Bihar-Nepal earthquake, and the 1950 Independence Day earthquake on the Arunachal-China border. Note that there are large spaces in between these earthquakes, where a major earthquake has not occurred for a long time. Scientists call these spaces *seismic gaps*, and it is more likely that the next major earthquake will occur in one of these gaps. The farther you are from the last earthquake, the closer you are to the next one.



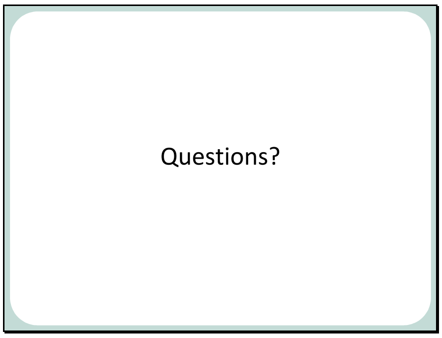
Explain that because of the ongoing collision shown previously, future earthquakes will affect Delhi. The Seismic Zone Map of India, at left, shows an estimate of how strong engineers and scientists think the shaking will be in various parts of India, based on past earthquakes. Delhi is in the second-highest hazard zone. You can mention that the map is a work in progress, and is updated when earthquakes happen or new information becomes available. Despite India's very long history, we have complete earthquake information for only about 200 years.



How strong the shaking feels at your location is described by a scientific term called *intensity*. Intensity is described on a scale of Roman numerals from I to XII (first row of table), and it is based on human perception of shaking (second row), damage to buildings (third row), and effects on nature. The map shows that the estimated intensity for the last big earthquake in north India, the 2005 Kashmir earthquake, was IV in Delhi – explain that this meant light shaking and no damage. Ask if anyone felt the earthquake. Note that the maximum expected intensity based on the Seismic Zoning Map is VIII. You should change the circle and arrow to fit the location of the training, as well as the box around VIII if your location is in a different seismic zone. Also, you can substitute an earthquake that occurred near the location of the training. The Amateur Seismic Centre website (www.asc-india.org) has many historical intensity maps for South Asia earthquakes.



When a damaging earthquake occurs, there will be a number of smaller earthquakes afterward that are called *aftershocks*. Some of these aftershocks will be large enough to cause additional damage on their own. Aftershocks normally decrease in size and frequency with time, so the largest and most potentially damaging aftershocks typically occur in the two weeks or so after the event. There is also a small chance that a larger earthquake could occur as well, though this is quite rare. After an earthquake happens, you should expect aftershocks and take appropriate safety precautions. You should think, "What could happen if an aftershock occurs while I'm doing this?" Don't go into buildings that are badly damaged and could collapse in an aftershock.



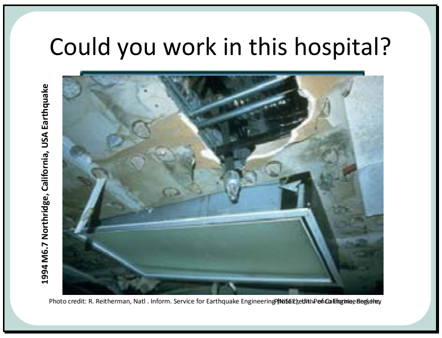
Answer questions from the participants. Limit the number of questions to keep on schedule. You can invite participants to ask additional questions at the tea break or at lunch.

In this section, we will talk about earthquake damage and what can happen to a hospital as a result.

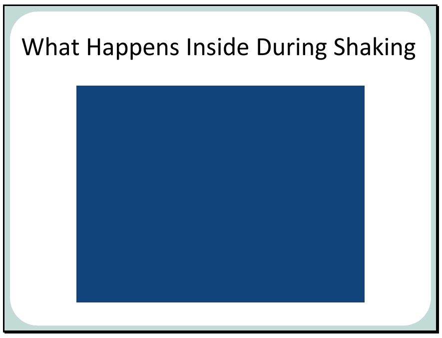
The building's structure, the parts that resist gravity loads acting vertically and earthquake forces acting horizontally (laterally), can be damaged by earthquakes. Damage can range from none to complete collapse. Major damage to load-bearing elements such as columns and bearing walls usually makes the building unsafe to re-enter. Every earthquake has aftershocks, so don't enter badly damaged buildings because an aftershock could cause them to collapse.

This building (the Jubilee Hospital in Bhuj) has partially collapsed – too dangerous to enter.

This building is leaning dangerously and is at a state of what structural engineers call "imminent collapse". It is very dangerous to enter such buildings because they could collapse in an aftershock. The man in the photo is living dangerously!

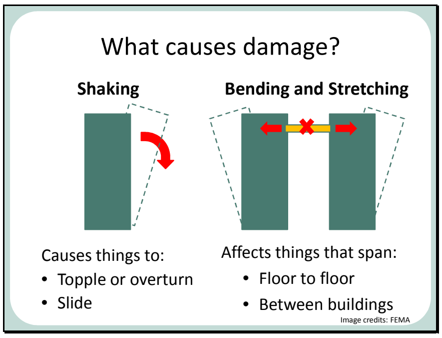


Tell the story of the old and new Olive View Medical Center buildings in the Los Angeles area of California to illustrate what can happen inside a hospital. The original hospital was new when it suffered structural damage in the 1971 San Fernando California earthquake that was so severe the hospital had to be demolished and rebuilt. The new hospital was built to be very strong, with large steel walls to resist earthquake forces. The hospital was tested again by the 1994 Northridge earthquake, and the building itself suffered no structural damage despite the shaking being very strong. However, there were numerous pipes that broke and caused water to leak (the 6th floor was flooded), the oxygen tank toppled, disrupting medical gas supply, and staff had difficulty getting to work because of a collapsed freeway. The hospital was evacuated for several days as a result mostly of the water damage. The new hospital should have been able to take in patients rather than evacuating them.



This video was taken by a camera inside a Japanese TV broadcast company office during the 1995 Kobe earthquake. Point out the employee spending the night in the office, who tries to protect himself by curling into a ball during the shaking.

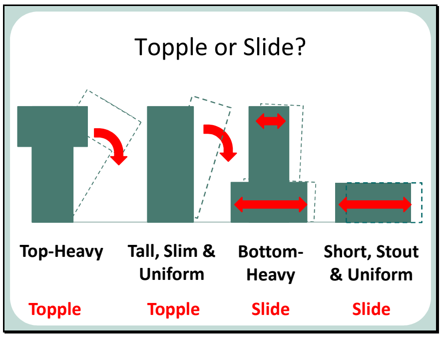
What would happen if this kind of shaking happened in your hospital? Will it be able to respond well? What will be the consequences?



Earthquakes cause damage to a building's equipment, contents, systems, and architectural elements in two major ways.

•The ground shakes the building back-and-forth, and then the building shakes everything that is in it or attached to it. Objects can tip over, slide, or break due to this back-and-forth motion. Tall, narrow objects are especially vulnerable to toppling.

•The earthquake motion causes the building to bend as it sways back and forth. Engineers call this motion deformation. Objects that are connected to two different floors get stretched or squeezed, and they can crack, bend or break. Objects like pipes that are connected to two different buildings can also get stretched or squeezed as the buildings move differently.



Bottom-heavy objects are much less likely to topple than top heavy objects with the same height-to-depth ratio, and are also much less likely to topple than objects with a uniform mass distribution and the same height-to-depth ratio. Top-heavy objects are the most likely to topple. Short stout objects and bottom-heavy objects are likely to slide.

Mention that objects on wheels will roll rather than slide. Rolling or sliding is almost always safer than toppling, both for people nearby and for the object itself.

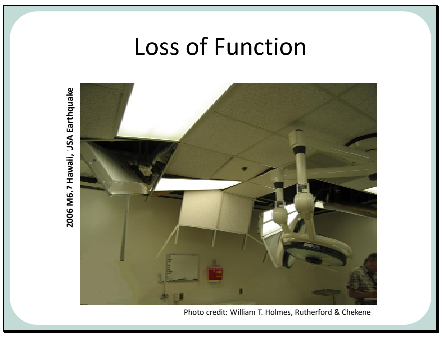
Consequences of Earthquake Damage

- Loss of life
- Loss of function
- Loss of property/money
- Loss of community confidence

These are the major consequences of damage to hospital equipment, building utility systems, contents and architectural elements. All of these consequences create secondary consequences in the community as well. For example, a loss of life will irreparably harm that person's family; if they are the primary provider or "breadwinner" then the family may really suffer financially as well. Loss of function may result in a decreased ability to provide care to the community, creating increased morbidity. Loss of property may cause resources to be diverted from advancing patient care to replacing the damaged/broken items.

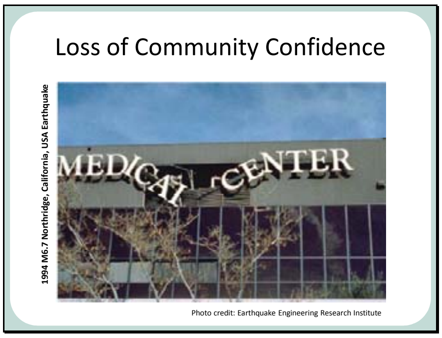
A large concrete panel (approximately 1 m x 2 m) fell from the exterior of a parking garage during the 1987 Whittier Narrows (Los Angeles area), California earthquake and killed a pedestrian – a young woman who was a university student. Whittier Narrows was not a major earthquake – magnitude 5.9. Many hospital buildings have similarly large and heavy concrete sunshades.

You may also want to mention major injuries ("loss of limb") in the loss of life category. A major injury can result in permanent disability. Permanent disabilities can cause a person to lose their current livelihood (depending on what they do), and can cause them to have to learn a new way to make a living.



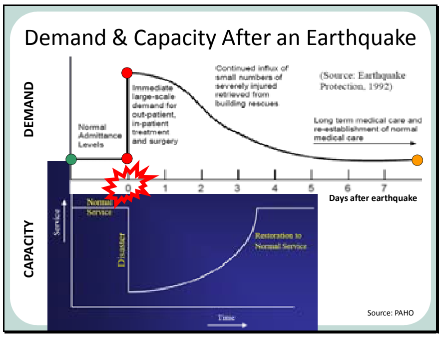
This OT at Kona Community Hospital in Hawaii was rendered non-functional by the collapse of the suspended ceiling. Besides the danger from parts of the ceiling and light fixtures hanging down, large amounts of accumulated dust fell into the OT.

This radiology equipment was damaged by the 1971 San Fernando earthquake and was not usable.



Would you want to go in this hospital?

The sign was knocked askew by mechanical equipment that slid off its supports in the mechanical room behind the sign.

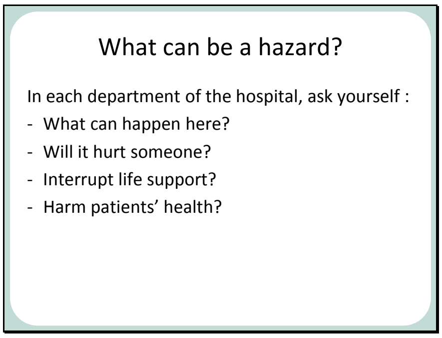


Following an earthquake, demand increases due to injuries in the surrounding community. The graph shows the medical care needs as a function of time. Ask what happens to the capacity of the hospital, and then click to bring up the capacity graph. In unprepared hospitals, capacity decreases substantially due to damage, staff not being able to come in (blocked roads, family crisis, or injured/killed themselves). The loss of function caused by the capacity decrease can also lead to a loss of community confidence.

Questions?

Answer questions from the participants. Limit the number of questions to keep on schedule. You can invite participants to ask additional questions at the tea break or at lunch.

In this section, we will discuss the major concepts of how to identify and mitigate risk, before we talk about specific objects.



Questions to ask:
-What can happen here? Visualize how things will move during an earthquake, and what will happen as a result. Will something overturn? Fall? Slide?

-Will it hurt someone? Examples: Falling cladding panel, large heavy objects that fall, slide or topple

-Interrupt life support? Examples: Emergency generator falls from supports = no emergency power = no life support

-Harm patient or staff health? Examples: Chemical spill in laboratory releases toxic gas; damaged radiology equipment releases radiation

Ask the attendees to find the hazards here.
The guard seen in the left-side photo is sitting in vulnerable spot where he could be injured by toppling equipment or falling glass shards. Broken glass on the floor in the doorway could cut the feet of people in sandals trying to exit the building after the earthquake. In the waiting room, the unbraced false ceiling, suspended fans, tall cabinet and equipment behind the desk and glass above the door also pose a hazard.

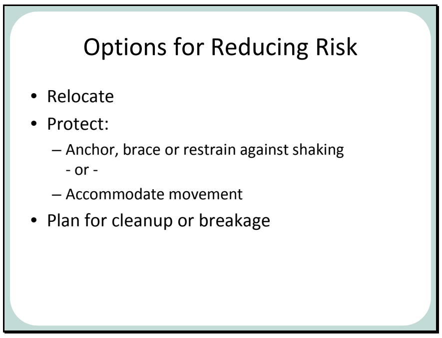
Ask the attendees to spot the potential problems in the laboratory. They include:
- Table top equipment can slide off
- Samples can be lost
- Computers with valuable data can fall down
- Glass beakers, vials and test tubes can fall and shatter.
- Glass fronts of cabinets can shatter if something heavy slides into them. Glass shards can cut feet.

Remember, someone's life could depend on the lab equipment and results.

Ask the attendees to spot the potential hazards in the ICU. They include:
- Monitors that are not well secured and can fall onto very fragile patients
- A portable X-ray machine that can topple and fall onto patients or break

Ask the attendees about the OT. Hazards include:
- OT lights that may not be properly secured to the ceiling
- Monitor atop the anaesthesia machine is likely to topple
- Other equipment on the anaesthesia machine cart may not be anchored and can fall out
- Glass windows can break

Ask attendees about potential problems in the NICU. They include:
- Radiant warmers can topple and very fragile babies can fall out
- Large glass windows can break and shards could fall on babies
- Tile veneer on wall can pop off and fall

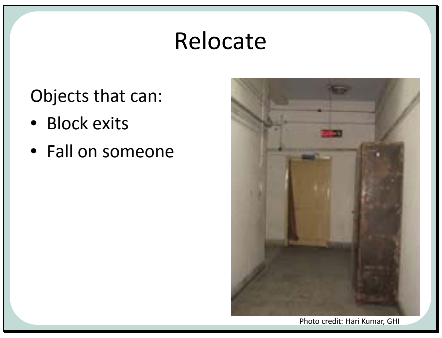


Explain that there are several ways to reduce risk from objects and systems.

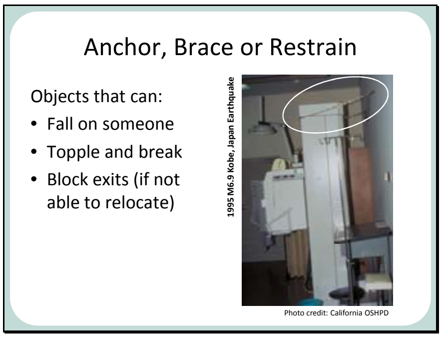
The first and simplest option is to relocate the item, if possible.

The second option is to anchor, brace, or otherwise restrain the object to keep it from falling, toppling, or sliding. Or, if the object connects two things that may move differently, accommodate the expected amount of movement.

If neither of the first two options is feasible (such as for equipment that is moved often and cannot be anchored), you can assume that the object will fall or break, and plan for that. For example, if adding shelf restraints in medical records will place too much of a burden on the staff during day-to-day operations, then there will need to be a plan to sort the records when the fall to the floor during an earthquake (sorting and re-filing records can take a tremendous amount of staff time). In Chile, the hospital staff was still sorting medical records nearly a month after the 2010 Chile earthquake.

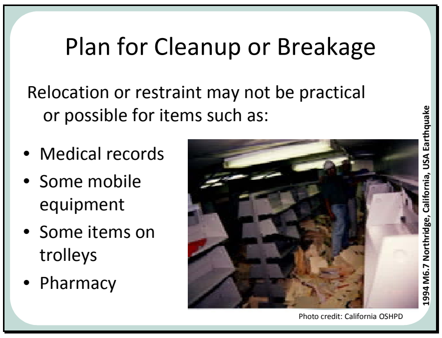


Cupboards placed like this are common sights in hospitals. Although it saves space within rooms, this practice can result in blocking the corridor - an important exit route.



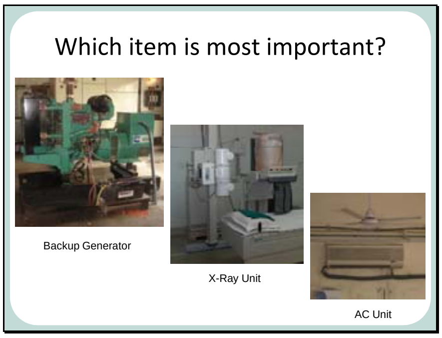
The imaging equipment shown was kept from overturning in the 1995 Kobe, Japan earthquake (a very strong event) by a simple chain restraint.

The photo shows flexible connections at the new Bhuj Civil Hospital. The flexible connectors accommodate the deformations between the building and the ground when the building moves back and forth on special sliders called base isolators, and they keep the pipes coming into the building from breaking. These connectors have to accommodate more deformation than most but the idea is the same as for other cases: determine the amount of differential displacement, and then provide a flexible connector that will accommodate that displacement.



If restraints or anchoring will interfere too much with functionality, you can simply plan for cleanup and/or breakage. Some examples might be shelved items like medical records, pharmacy, or some supplies. Also items on trolleys and some overturning-prone mobile equipment may fall into this category. The photos shows a pile of medical records approximately a meter deep that fell from shelves during the 1994 Northridge, California earthquake. After the 2010 Maule, Chile earthquake, hospital workers were still sorting fallen medical records nearly a month after the earthquake.

It's very important to talk with colleagues on facilities staff to help them devise an anchoring solution that will work for you. You must make sure your concerns are addressed. If they use an anchoring solution that interferes with your work or their ability to use equipment, the restraints could just be undone or won't be used, and you won't be as safe. Some items may not be able to be anchored at all (because they are in use so much), and so you will need to have a backup plan in case the object is damaged. Work together with everyone who works in a certain area to select a solution or mitigation strategy everyone can live with.



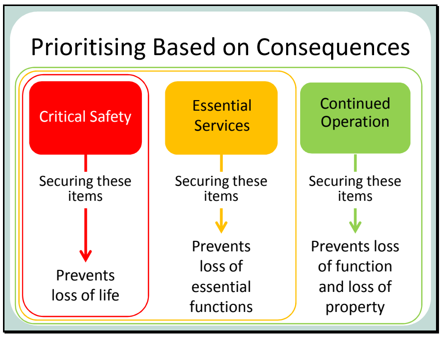
Some items will be more critical than others – you will use your resources most effectively if you make a plan for which items to address first. Ask the audience which item they think is most important: the backup generator, an X-ray machine, or an air conditioner.

One way to prioritize is to determine the consequences if the object falls or breaks.

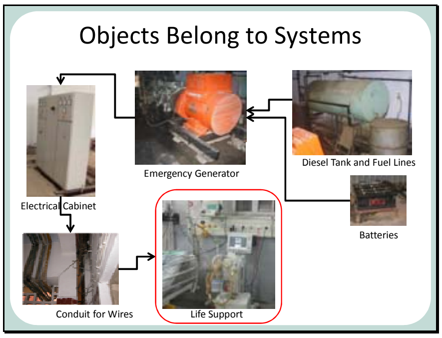
For example, if your backup generator falls from its supports, the hospital will not have emergency power – grid power is certain to go out after an earthquake. Patients on life support could die.

However, if your air conditioning system fails, it will be uncomfortable, but it will be unlikely that anyone would die as a result.

In our manual, we put items into three different categories, based on the consequences.



Explain the red (Critical Safety), yellow (Essential Services), and green (Continued Operation) performance goals from the manual. Securing all the red items is intended to prevent the loss of life in an earthquake (and subsequent problems like fire following the earthquake). We recommend anchoring all the items needed to achieve the Critical Safety level of performance as a minimum, near-term goal. Securing all the yellow items as well as the red items is intended to keep the hospital's essential services functioning. These services will either maintain care for very ill patients (ICU, NICU) or enable the hospital to care for those injured by the earthquake (Emergency Department, OTs). Securing the green items as well as the yellow and red items is intended to minimize the disruption to hospital operations as well as the cost of replacing equipment and repairing other items.



Look at systems and performance, not just individual objects. What do you want your hospital to be able to do? Try to prioritize according to systems. For example, what would it take to protect the emergency power system? You will need to make sure the emergency generator is anchored first. But you will also need to look at the day tank and fuel lines that supply fuel from the tank to the generator, as well as the batteries needed to start the generator. How will the power generated get to the life support equipment in the ICU? You will need to ensure that cabinets with switchgear are anchored, and that conduits and wiring can accommodate differential movement at building separations.

Who Can Help

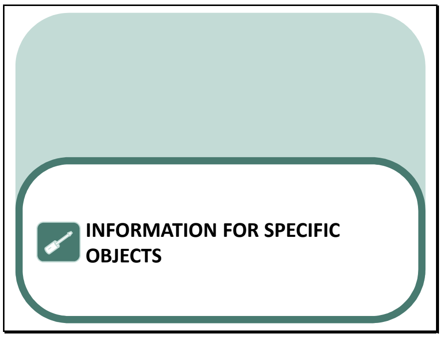
- Handyman can anchor many items
- You will need a tradesperson for:
  - Any work involving building utility systems
- You will need an engineer for:
  - Objects too heavy for two people to lift
  - Sensitive medical equipment; hazardous materials

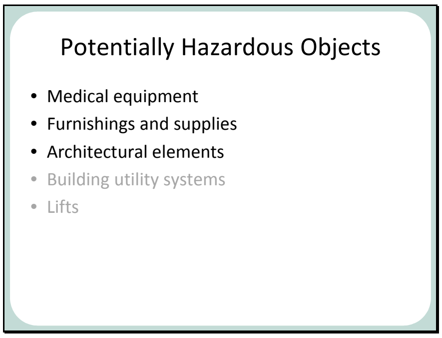
Doctors may not be doing much of the actual anchoring of items, but we need to empower them to support efforts to protect items, and to anchor things themselves if needed. A handyman can anchor many items that don't require specialized training or expertise. Any work on building utility systems will require the appropriate tradesperson: plumber for water pipes, electrician for electrical power system, etc. They will need the help of an engineer for some larger items that are typically too heavy for do-it-yourself anchoring. These items include major mechanical and electrical equipment, large medical equipment (esp. imaging/scanning units), window unit air coolers, large racks and shelving systems (such as for medical records), exterior architectural features (parapets, sunshades, canopies, etc.), brick partition walls, and tanks. Usually, if it is too heavy for two people to lift when working together, you might need an engineer.

Facilities should be able to provide the help needed for many common objects, though if the hospital does not have an actual engineer on staff, then you will need to look outside the hospital for help.

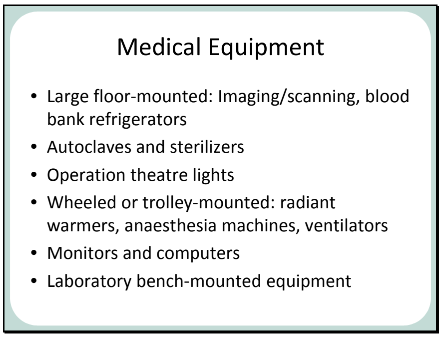
Questions?

Answer any questions. If things are running behind, you can ask the participants to ask their questions during the tea break, which is scheduled to happen now. Also, you will have time during the break to talk to participants one by one and provide more detailed answers.



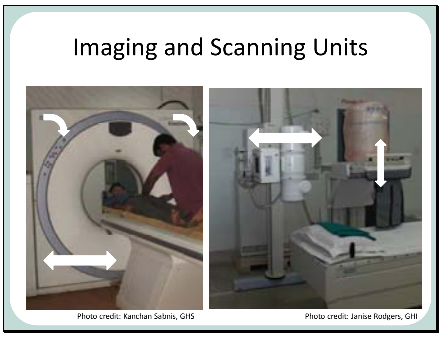


Explain that you will present vulnerabilities and potential solutions for different categories of objects. You won't cover every object that trainees may see, but you will cover objects that are present in doctor's workspaces. We won't cover the objects in grey that relate to building utility systems (mechanical and electrical equipment; pipes ducts and conduits; tanks; lifts) because these are not objects that doctors will deal with directly on a daily basis. Maintenance/facilities/engineering will handle those items.

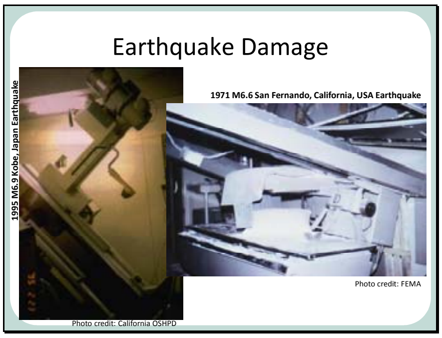


Explain that we will not attempt to cover all the specific medical equipment in a hospital. We will go over common or particularly vulnerable items, as well as equipment that is particularly important in the post-earthquake period.

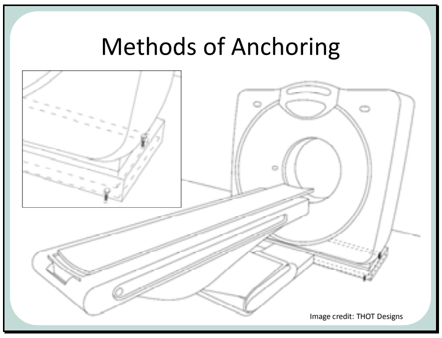
Note that some equipment cannot be anchored for functional reasons, and that all anchorage solutions must be developed and discussed with user input – otherwise they may be removed by users.



Some of the largest and most expensive equipment in the hospital is imaging and scanning units. You will want your imaging equipment to be functional after an earthquake, because fractures are some of the most common injuries caused by earthquake damage.

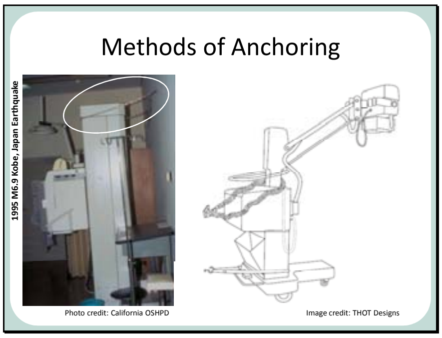


Earthquake damage to imaging equipment. If equipment, such as an X-ray machine, which uses radiation to generate images suffers enough damage, there could be a dangerous radiation leak.



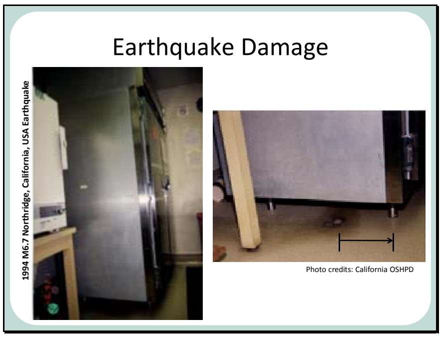
Fixed units should be anchored to the floor with bolts per the manufacturer's instructions, and most are. You should check to ensure that the machine is in fact bolted to the floor properly, though. Manufacturers that sell these machines in areas such as California and Japan (i.e., most major manufacturers) should be able to provide guidance for how to anchor their equipment to resist earthquake shaking (i.e., the type of bolts, and how they should be installed.).

Mobile units should not be anchored. If the equipment is prone to toppling, you can park it in a "garage" or attach a tether when it is not in use. Mobile equipment that is not prone to toppling can be allowed to roll around, except in special circumstances (like very heavy equipment that could crush nearby vulnerable patients – but this will be rare).

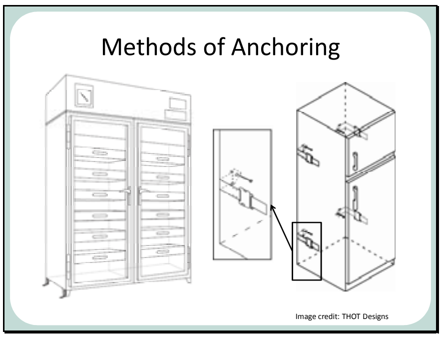


The equipment above was prevented from toppling during the 1995 Kobe, Japan earthquake by a simple chain restraint. Such simple restraints can be a good option for equipment that has to be moved infrequently.

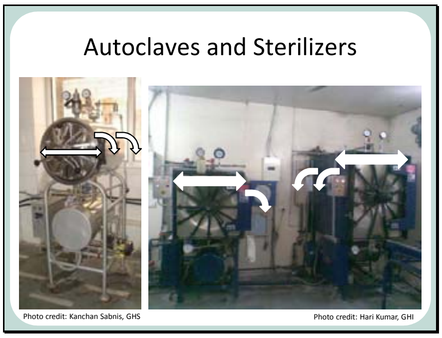
Blood bank refrigerators can topple, or if the door does not have a proper latch it can come open. If it comes open the blood bags can fall out, or the door may not close properly and the blood may spoil.



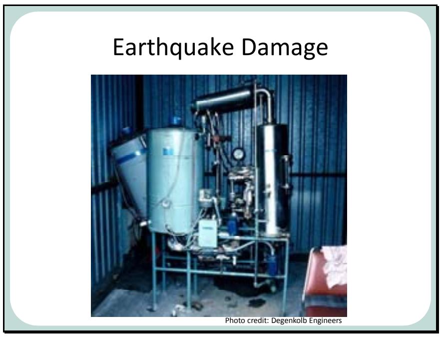
This blood bank refrigerator slid approximately 100 cm during the 1994 Northridge, California earthquake. Refrigerators that slide far enough can become disconnected from the electrical power source. Refrigerators can also topple and cause loss of blood when it is needed most.



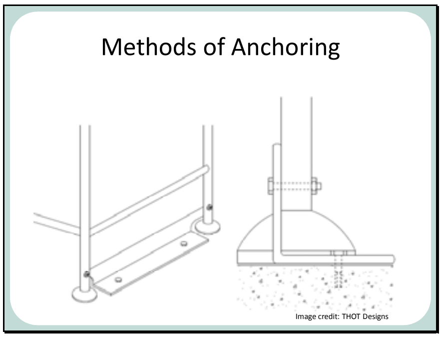
Anchor large blood bank refrigerators to the floor to prevent them from toppling. Smaller refrigerators can be anchored using straps or L-clamps at the top. (Such L-clamps are anchored to the wall but touch the top of the refrigerator rather than being screwed into it.) Ensure that there is a door latch installed if you are using an ordinary refrigerator designed for home use. (Most commercial blood bank refrigerators have latches.)



Autoclaves that are tall and narrow can topple.



Equipment that is tall and narrow like many autoclaves was damaged in a California earthquake.

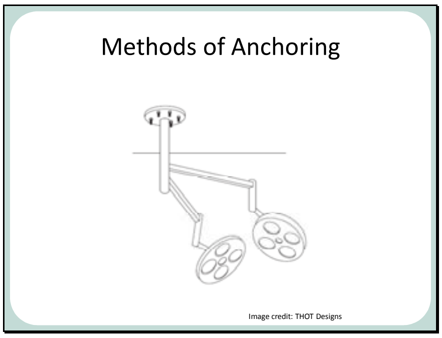


Legs of standalone autoclaves can be anchored to the floor using an angle iron. Chest-type autoclaves can be anchored to the floor or can be built into the wall. Ensure that there are flexible connections to water pipes to prevent pipes from breaking.

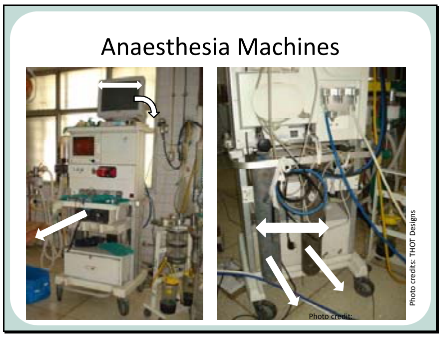
OT lights can swing, become damaged, and fall on doctors, nurses and patients.

An OT light broke and fell during an earthquake simulation experiment. This type of failure has not been observed in the field after earthquakes, but it could happen.

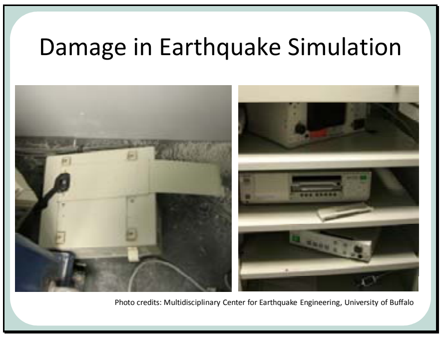
If anyone asks “what is an earthquake simulation experiment?” explain that researchers use a piece of equipment called a *shaking table* to simulate earthquakes and their effects on buildings, bridges, and equipment. A shaking table has a platform with large jacks underneath that move it back and forth to simulate an earthquake. Researchers attach models of the items they wish to test to the platform, and then they shake them with a simulated earthquake and observe what happens.



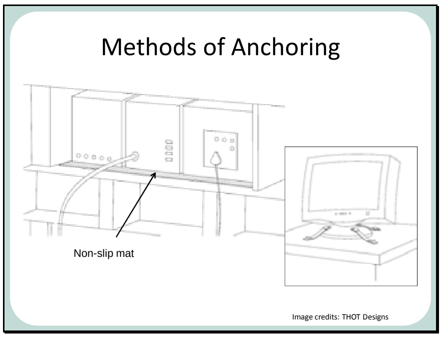
OT lights need to bolted directly into the structural ceiling, or braced back to the ceiling if there is a suspended ceiling. Suspended ceilings are not strong enough to keep the lights from swinging and falling.



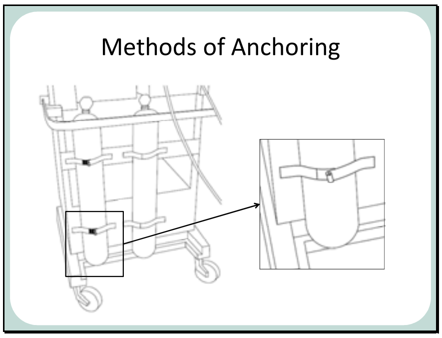
Equipment on shelves and the monitor at the top can fall off. Cylinders can break their mounting connections and fall off.



Medical electronic equipment similar to that in an anaesthesia machine fell and shifted during an earthquake simulation experiment.

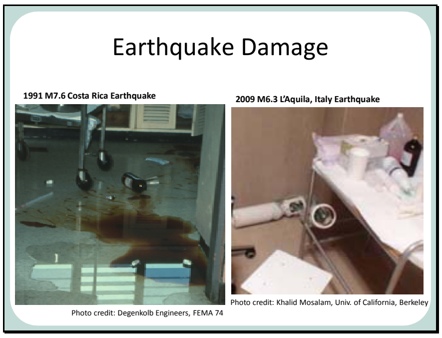


Provide non-slip mats to keep equipment with low aspect ratios (i.e., much wider than tall) from sliding off of shelves. Monitors, especially those sitting on top of anaesthesia machines, can be attached with clips and straps.

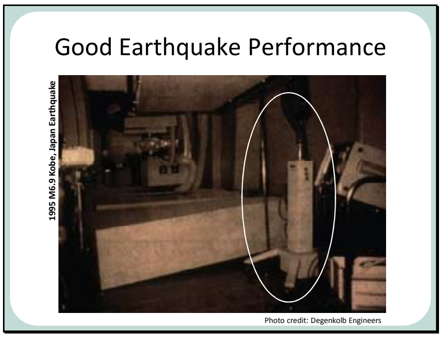


You can use hook and loop tape or straps to secure cylinders to the back of the anaesthesia machine. The mounting connection (where the cylinder is attached to provide gas) may not be strong enough to resist earthquake forces, so provide additional support.

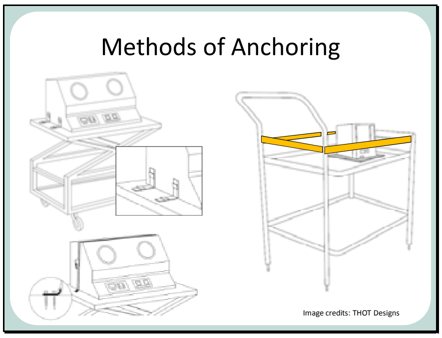
Equipment mounted on trolleys can slide off if it is not anchored. Supplies on trolleys can spill; glass bottles can break and their contents can spill or mix. Tall and narrow wheeled equipment may be prone to toppling unless it is bottom-heavy.



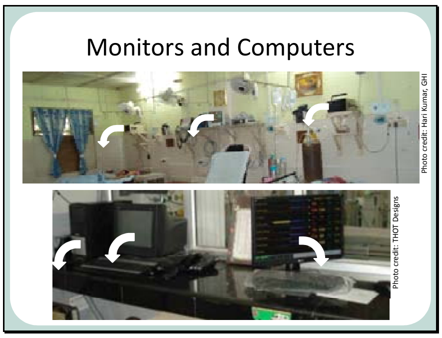
Chemical spill in Costa Rica earthquake; medical gas cylinders fell in the L'Aquila earthquake in Italy.



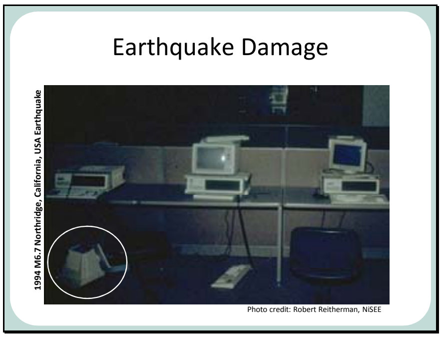
Bottom-heavy wheeled equipment did not topple during the 1995 Kobe, Japan earthquake. Cabinets and other equipment toppled.



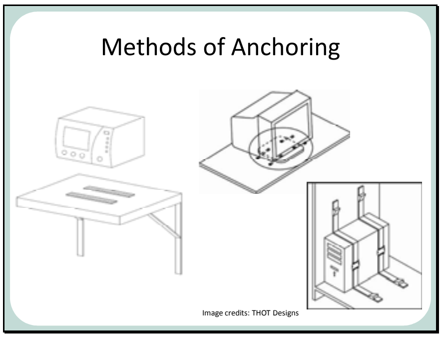
Equipment on trolleys can be anchored with clips or straps. Non-slip mats should be used to increase friction and help prevent sliding of short, squat equipment. Having guard rails around the counter-tops of trolleys will help prevent equipment from sliding off. Supplies on trolleys can be placed in bins, which in turn can be kept from toppling with rails or shelf lips.



Monitors placed on shelves or other surfaces without a positive connection could topple. Those directly above beds of vulnerable patients are the most hazardous.



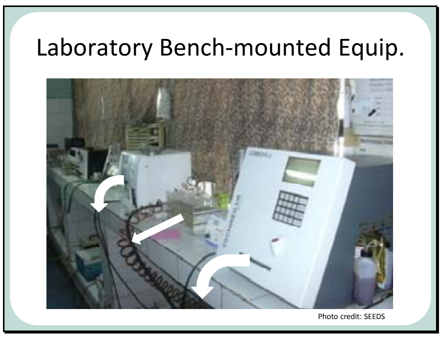
The monitor at left fell from the table during the 1994 Northridge earthquake.



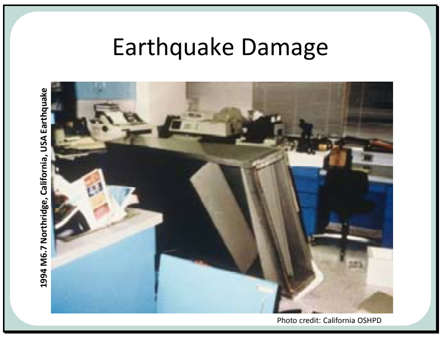
Small monitors can be secured with hook-and-loop tape or be placed on non-slip mats. Also, small shelf lips or rails on carts can help prevent equipment from sliding and falling. Wall-mounted monitors should have brackets that are designed to withstand earthquake forces.

Computers and computer monitors can be anchored with special clips and straps. CPUs should be kept near the floor as much as possible. Thin straps (used in shoulder bags) can be used to restrain CPUs. Most cathode ray tube (traditional) computer monitors will not slide if a non-slip mat is provided. Straps as above can also be used for additional restraint. Flat panel monitors are taller and thinner and thus more prone to toppling; consider using straps for additional restraint.

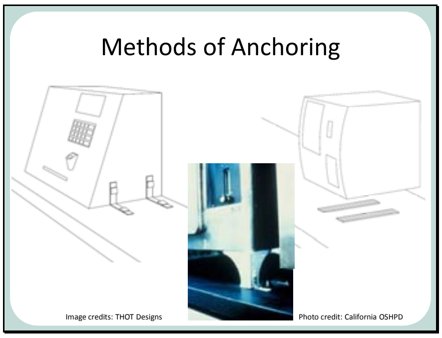
Prioritize the level of restraint and the functionality requirements depending on the use of the computer. For example, computers used for critical clinical purposes will be a higher priority than basic computers in administrative offices.



Laboratory equipment can fall from benches.

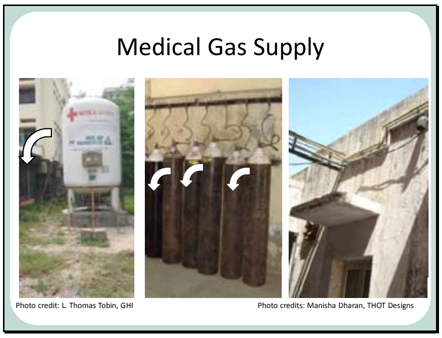


Damage to a laboratory in the 1994 Northridge, California earthquake.



There are many restraints available for laboratory equipment. Items that do not need to be moved can be bolted to the bench-top. Other options are straps and hook-and-loop tape.

You can develop your own solutions as well using available materials.



Medical gas storage and distribution can be vulnerable to earthquake damage. Strong shaking can cause unrestrained cylinders or inadequately anchored tanks to topple. Cylinders connected to manifolds can break their connections. Medical gas distribution pipes can break, especially if they cross areas where relative movement is going to occur.

The oxygen tank at the New Olive View Medical Center toppled during the 1994 Northridge, California, USA earthquake.
Unrestrained cylinders toppled over.

Methods of Anchoring

Photo credit: William T. Holmes, Rutherford & Chekene

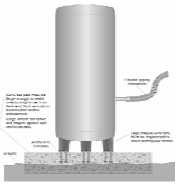


Image credit: FEMA 74

Gas cylinders can be anchored with chains to either a wall or a separate frame.

Tanks should be properly anchored at the base. It is very important to look at all portions of the seismic load path, the route the forces take to get from the object to the ground. Failures have occurred at all these points: connection of the tank to its legs, connection of the legs to the concrete pad, and design of concrete pad.

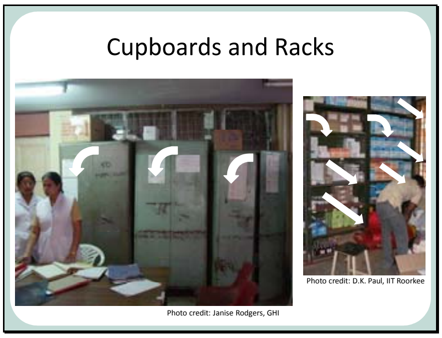
For medical gas distribution pipes, provide flexible connectors wherever there could be significant differential movement: at connections to equipment, and where pipes span between two different buildings or floor and ceiling.

Questions?

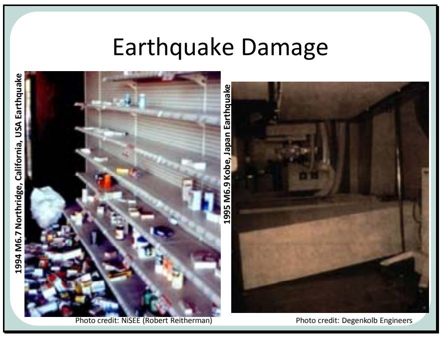
Take any questions before moving on to Furnishings and Hospital Administrative Systems.

Furnishings, Supplies, and Architectural Elements

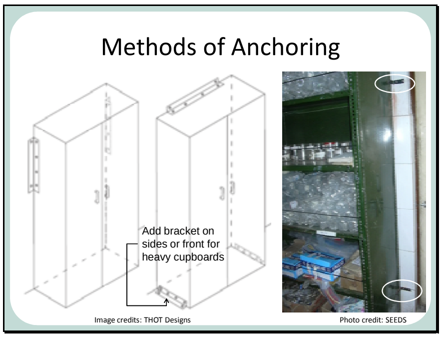
- Cupboards and racks
- Pharmacy
- Sterile Storage
- Pendant lights and fans
- Falling hazards on the outside of buildings



Cupboards can topple, and contents can fall out, or spill inside and mix. Unsecured racks can topple, and items on racks can fall to the floor. Racks for sterile storage can topple or spill sterile items onto the floor (and they won't be sterile anymore).



Spilled contents in California and toppled cupboards in Japan.

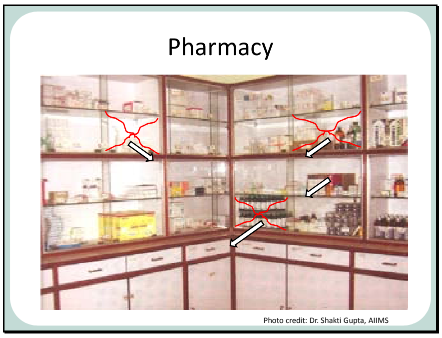


Cupboards are easy to restrain, but you will need to anchor them adequately. Heavier cupboards may need attachment at both top and base, especially if the wall strength is questionable.

Shelf restraints can be as simple as a wire spring attached with a nail at each end.

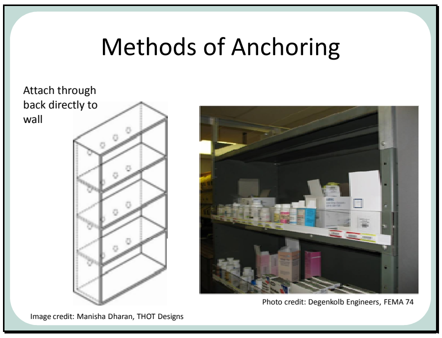
The process for installing simple spring shelf restraints:

- Obtain materials: springs and nails, plus hammer and pliers
- Nail through eye at one end of spring
- Stretch spring (not too tightly) and nail other end

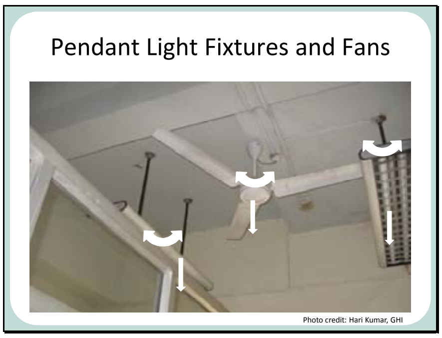


Glass in pharmacy can break, and medicines can fall down and spill.

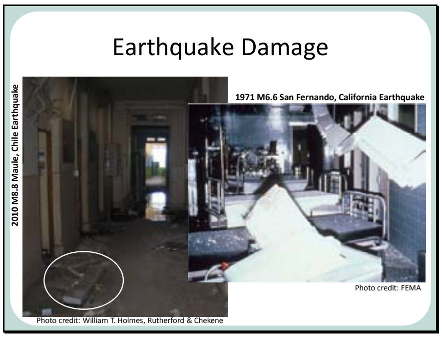
Spilled pharmaceuticals and chemicals.



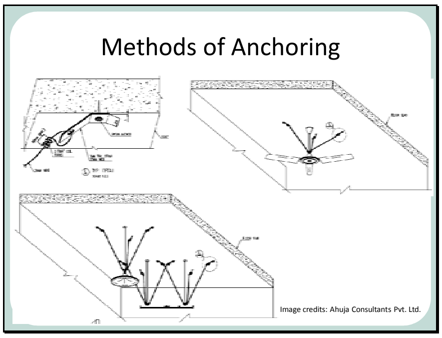
Pharmacy cupboards and racks can be attached directly to the wall by drilling through the back. The clear shelf restraints are shatterproof Plexiglas. Safety glass that does not fall from the frame when it breaks can also be used in glass-fronted pharmacy cabinets. You can also use the simple spring shelf restraints shown earlier.



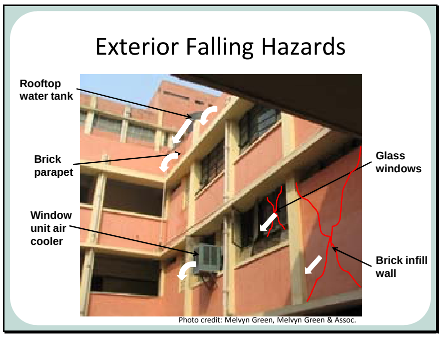
Pendant light fixtures and ceiling fans on rods will swing and can break the connection at the ceiling. Light fixtures and fans on chains, wire rope, or cables are safe, provided that the chain/rope/cable is attached securely with a closed circle hook or other device, so that it can't slip off.



Fallen pendant lights in hospitals in Chile and California.



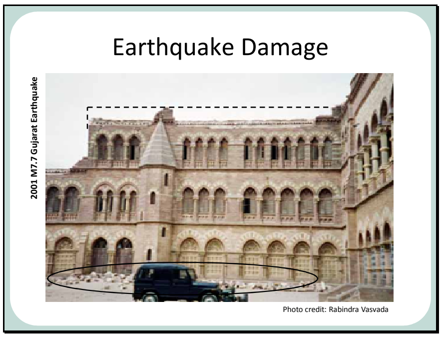
You can limit the swing of a light fixture or fan on rods by providing wires that attach the light or fan body to the ceiling. This should prevent the connection at the ceiling from failing. Alternatively, you can replace the rod with a chain, wire rope, or cable and allow the light to swing. Swinging will not harm the light, if the fluorescent tubes have restraint devices like the wires around the fixture shown above right, to keep them from falling out. Screw-in globe bulbs do not need additional restraints.



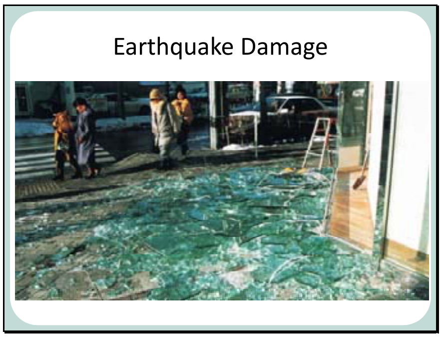
There are a number of potential falling hazards on the exterior of buildings. Many hospital buildings have:
-Unreinforced brick parapets or balcony walls
-Window unit air coolers
-Unanchored plastic rooftop water tanks
-Plain glass windows (i.e., not safety glass or tempered glass)
-Unreinforced brick partition walls
Unreinforced brick parapets, window unit air coolers, and unanchored rooftop water tanks are major falling hazards. They do not typically have any lateral restraints and can easily topple, even if the earthquake shaking is not very strong. These items are often located above exits or areas where people congregate.

Windows made of ordinary glass rather than safety glass or tempered glass can break into large shards as the building bends back and forth and stretches the window frames. These shards can fall down onto people below. Windows are often located above exits or locations where people congregate. In a similar fashion, unreinforced brick infill walls can crack and fall out of the frame during earthquakes.

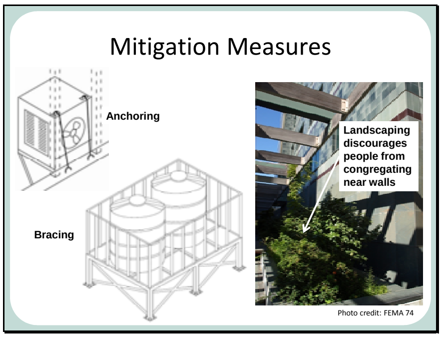
All these items falling from the building exterior create a “kill zone” near the building walls during an earthquake. People trying to run out of buildings have to cross this zone to exit, and people have died during earthquakes as a result.



The parapet on this building used to be where the dashed line is, but it fell during the 2001 Gujarat earthquake. The fallen stones can be seen on the ground in front of the building (behind the vehicle). Note the lack of other damage to the building. Unreinforced masonry parapets are one of the most vulnerable parts of a building and often topple at levels of shaking that are not high enough to cause other structural damage.

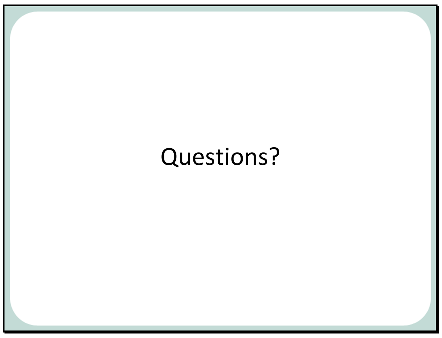


Would you want to be on this sidewalk during an earthquake?

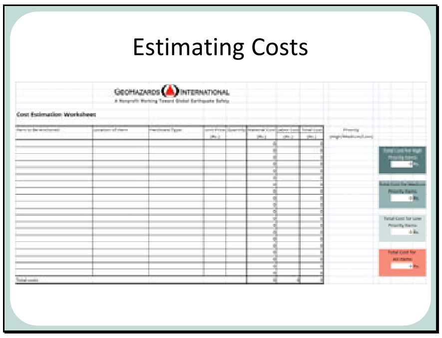


As an interim measure, you can plant landscaping that discourages people from congregating near walls. It will be important to maintain the landscaping and ensure that plants are not inviting – use shrubs rather than grass.

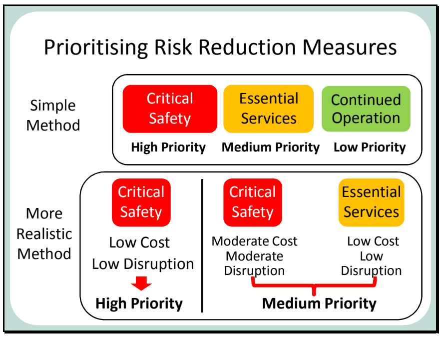
This is a measure that can be used to keep people away from any dangerous areas outside buildings. The building shown has exterior tile veneer, and tiles are likely to fall off during an earthquake. The landscaping was planted to keep people away from the walls. (The building is on the University of California, Berkeley campus.)



Answer any final questions, and make yourself available during the tea break for discussions with trainees.

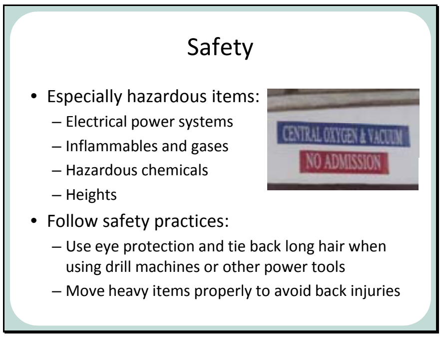


This spreadsheet can be downloaded from the GHI website.



Explain that you can prioritise risk reduction measures in several ways. The simplest way would be to make all the Critical Safety items high priority, the Essential Services items medium priority, and the Continued Operation items low priority. You would fix all the high priority items, then all the medium priority items, and lastly all the low priority items. But realistically, you might take care of some of the Essential Services items before all of the Critical Safety items are finished, because those Essential Services items are less costly and less disruptive, or because specific staff members are motivated to make their work spaces safer. We should encourage staff to improve safety by incorporating their wishes.

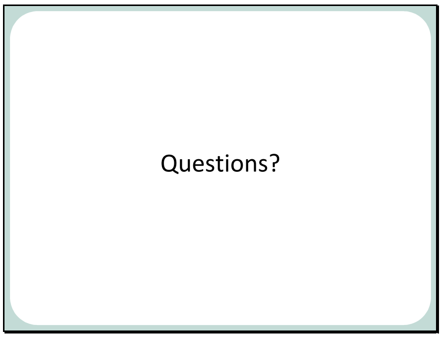
A more customized approach, shown on the bottom, would also consider cost and disruption. For example, Critical Safety items that are easy to fix or inexpensive would be still be high priority – the "low hanging fruit". Medium priority items would include Critical Safety items that are more expensive and disruptive to fix, plus Essential Services items that are easy to fix or inexpensive. The remaining items would be low priority.



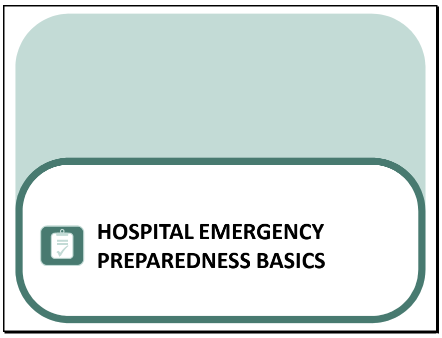
Safety is very important when installing seismic restraints. It is inherently hazardous to work on many of the utility systems and equipment in a hospital. Doctors should not be working on these systems but should be aware of the potential safety hazards. Some areas of particular concern are electrical power systems, inflammable fuels, gases, hazardous chemicals, and heights that expose workers to a potentially deadly fall. ONLY qualified tradespeople should work with electrical, fuel, and gas systems. These persons should follow established safety protocols for their trade. Any doctors anchoring smaller items should follow safety protocols appropriate to those items:

-When using power tools like a drill machine, tie back long hair and wear eye protection

-Use care when shifting or positioning items like cupboards to avoid back injuries



Answer questions from the participants. Limit the number of questions to keep on schedule. You can invite participants to ask additional questions at the end of the day.



Before an Earthquake

- Form a hospital safety committee
- Understand the hazards you face
- Assess your risk and impacts on ability to provide care
- Train your staff and drill regularly
- Make the following plans:
  - Mitigation plan
  - Emergency response plan
  - Continuity of operations plan
  - Continuity of business plan
- Identify alternative sites/facilities to operate from

There are a number of actions that hospitals should take to prepare themselves before an earthquake strikes. If you have not already done so, form a hospital safety committee that can address all hazards (natural and manmade) the hospital faces. The safety committee will guide the hospital through the remaining activities.

The hospital safety committee will be responsible for assessing and reducing risks from earthquakes and other hazards, and for developing the hospital's emergency preparedness plans. The hospital should have one committee that will address all hazards and emergencies; subcommittees can focus on particular hazards.

Hospital Safety Committee

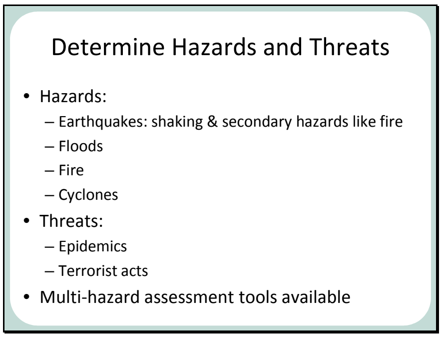
Representatives from all departments, including:

- Administration
- Doctors and nurses
- Medical departments: ED, Radiology, etc.
- Facilities/engineering
- Security
- Laboratories
- Housekeeping

It is very important that the committee have representation from all departments, so that everyone in the hospital will be working together and the needs and roles of every department will be understood. The problems and solutions associated with earthquake performance are interrelated and involve people with different responsibilities and areas of specialty. All of these points of view are important for proper performance. If the solution, anchoring something for example, creates problems for the user, then the anchor will be undone and the unsafe condition perpetuated. Cooperation leads to better understanding, better solutions and people who believe in the need to do things right.

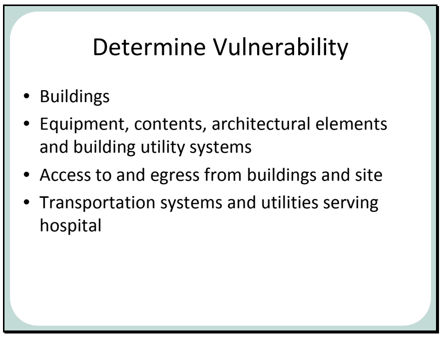
The hospital safety committee will need to make several different plans, including the following: an emergency response (life safety) plan, a hazard mitigation plan, an emergency operations and continuity of operations plan, and a continuity of business plan.

Remind participants of the concept of resilience that we introduced at the beginning of yesterday's session. Looking at the planning process from a resilience perspective means that you will set goals and timeframes for returning to normal operations as quickly as possible, and for providing adequate care in the meantime.

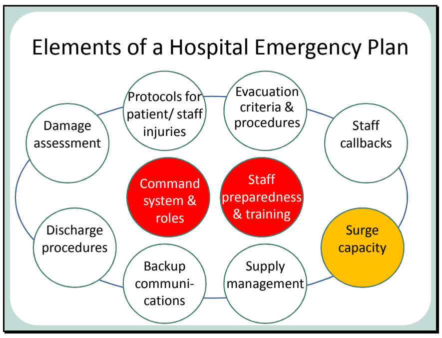


Risk assessment is the first step in understanding the challenges you may face. Mention that the hospital safety committee should address all the potential hazards and threats the hospital faces as part of a comprehensive safety program.

Multi-hazard assessment tools are available from Pan American Health Organization (PAHO), Kaiser Permanente (a large managed-care organization in the US), and others. GHI can provide tools to help with risk assessment upon request.

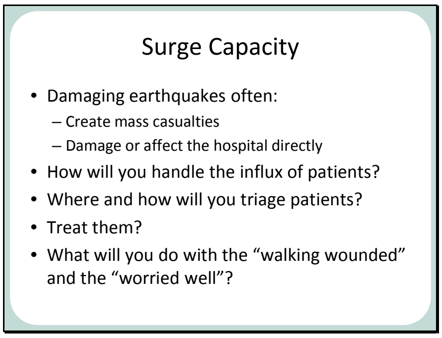


As part of your risk assessment, you will need to determine the vulnerability of not only the hospital's buildings, but also of the objects and systems that keep the hospital functioning. These include all the equipment, contents, architectural elements and utility systems within the buildings, which we are discussing today. Also, you need to look at access to and egress from the buildings and site – can you get in and out of the hospital? You also need to consider the transportation systems (roads, rail lines, transit systems) that people use to get to the hospital, and the utilities serving the hospital, such as sewer, water and power.



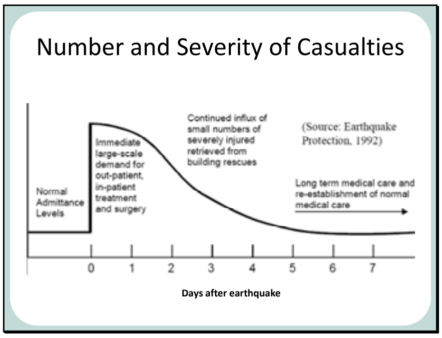
Describe some of the elements a hospital emergency plan should contain, and hand out either an example plan or the HICS earthquake planning guide. You should mention the following areas that plans should address:
-Command system and organization: Who will have which roles, and who are the back-ups? Plans should not depend on any one person.
-Damage assessment: Assess damage to facility
-Protocols for patient / staff injuries: What to do if people already at the hospital (staff and patients mostly) are injured?
-Evacuation criteria and procedures: What triggers and evacuation and how to conduct the evacuation. Evacuation can be dangerous for fragile patients, so only evacuate if really necessary.

-Surge capacity: How will you handle an influx of patients from the community? Have specific plans and procedures in place.
-Discharge procedures: How will you discharge existing patients that have less severe conditions in order to free up beds for those severely injured by the earthquake?
-Staff callbacks: How will you reach staff that are not on duty and have them return to work to help handle the influx of patients?
-Backup communications: How will you communicate if landline and mobile phone service is down?
-Supply management: How will you manage your existing supplies, given that it may be difficult to get more in the short term (< 72 hours).
-Networking with other hospitals: How will you communicate with other hospitals and share information and resources – networking affects several elements of the hospital emergency plan.



Surge capacity (the ability to handle an influx of patients) and procedures for mass casualty management are key elements of the hospital emergency plan. Plans to handle mass casualty events can be applicable to other natural and man-made hazards. Mass casualty management plans can be based on the number of casualties generated by an event; the type of event may be less important than the number of casualties. Having a plan will be important for things like bus crashes or bombings (hopefully not, but best to be prepared) as well as an earthquake.

For earthquakes, the number and severity of casualties that present at nearby hospitals depends on a number of factors. Building collapses are the main culprit in severe injuries, while falling hazards can create a large number of "walking wounded" as well as fewer severe injuries. The number of building collapses will vary greatly depending on the vulnerability of local buildings and the strength of the earthquake shaking. There will also inevitably be some "worried well" – people who are not actually injured but want reassurance that they are okay.



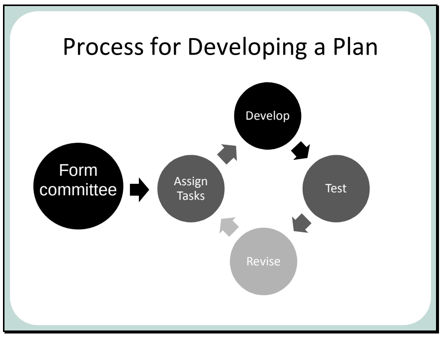
The shape of this curve will also depend on how badly the transportation network has been damaged. In Pakistan in 2005 and Sichuan in 2008, badly injured people were still arriving at hospitals over a week after the earthquake. In both those earthquakes, there were badly hit remote areas that were completely cut off for several days, and the transportation network in the mountainous earthquake-affected region was destroyed.

However, it is common that the “walking wounded” – those with minor injuries such as lacerations and simple fractures – will arrive at the hospital before those with more severe injuries arrive. (This happens because those with minor injuries are more able to transport themselves to the hospital, while those with more severe injuries must be extracted and brought by others.) It will be important for the hospital to have a triage plan so that resources are available to treat the more severely injured that will arrive later.

However, the medical response for the severely injured will be conducted in hours, rather than days, because people die when severe injuries are not treated quickly. Injured victims that have been trapped for days will still need immediate care after being rescued.

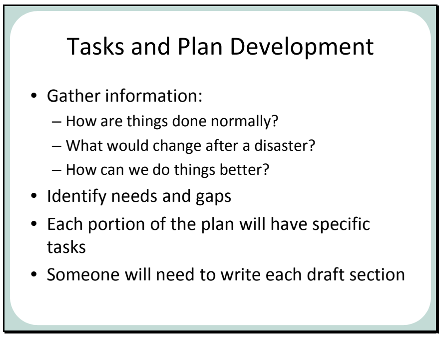
If asked about the types of injuries caused by earthquake damage, there is an entire field called disaster medicine that is outside the scope of this training course. There are numerous resources, including information in the scientific literature from recent earthquakes around the world. A quick and partial summary: building collapses cause the majority of severe injuries, though some may also be caused by falling objects or from falls when trying to exit during strong shaking. Falling objects often cause minor injuries such as lacerations and contusions that add to the overall demand on medical facilities. In building collapses, fractures are very common. Orthopedic, cranio-cerebral, thoracic, and abdominal injuries are also common. Another group of people that will come to the hospital are those whose pre-existing conditions are exacerbated by the earthquake such as heart conditions exacerbated by psychological stress or pulmonary conditions exacerbated by dust from building collapses and demolition, and those with chronic conditions worsened by lack of regular medication or treatment.

People rescued after being trapped under rubble for some time may have additional complications. They are likely to be dehydrated, and if a limb was pinned, they may suffer from crush injuries, crush syndrome, and related complications.



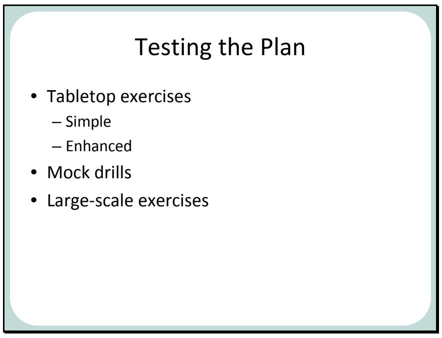
The process for developing your hospital's emergency plan will begin with the formation of a safety committee, either at the direction of an administrator or because leaders within the staff come forward and champion the effort.

Emphasize that the process of developing, testing and revising a plan is an ongoing effort that must involve all facets of hospital operations in order to be successful.



When making the hospital emergency plan, it will be important to assign specific tasks to individuals so that someone on the committee will be responsible for each item. This will help spread out the workload and will also create accountability.

Many of the initial tasks will involve gathering information: finding out what is already being done, and how that can be leveraged or modified. The committee will need to identify gaps as well as how things could be done better.



Discuss the options for testing the plan. Many audience members will not be aware of the potential exercises and drills, or what they are called, so explain all the types of drill you are going to mention.

In all these cases you will need a scenario upon which to base the exercise. A scenario can be simple or complex.

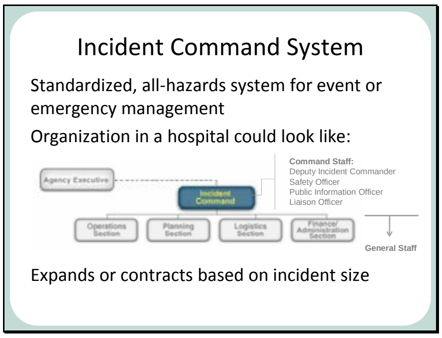
Simple tabletop exercise (definition from US Environmental Protection Agency): A facilitated analysis of an emergency situation in an informal, stress-free environment. It is designed to elicit constructive discussion as participants examine and resolve problems based on existing operational plans and identify where those plans need to be refined. There is minimal attempt at simulation in a tabletop exercise. Equipment is not used, resources are not deployed, and time pressures are not introduced. This is the simplest type of exercise to conduct in terms of planning, preparation, and coordination.

Enhanced tabletop exercise (definition from US EPA): An enhanced tabletop exercise is a simulated interactive exercise that helps to test the capability of an organization to respond to a simulated event. The exercise tests multiple functions of an organization's emergency response plan. It is a coordinated response to a situation in a time-pressured, realistic simulation that involves several agencies. An enhanced tabletop exercise focuses on the coordination, integration, and interaction of an organization's policies, procedures, roles, and responsibilities before, during, or after the simulated event. This type of exercise will require much more planning, preparation, and coordination than a simple tabletop exercise.

Mock drills: A mock drill is a simulation of an emergency event that is used to test emergency preparedness procedures and plans, and allow participants to physically practice what they would do in a real emergency. For example, participants would practice protective actions such as drop, cover and hold on during an earthquake mock drill. The mock drill can be simple or detailed, and it typically tests segments of an organization's emergency plan related to a particular hazard (for example, there can be mock drills for fire, earthquake, etc.). It can involve role players who pretend to be injured or trapped.

Large-scale exercises: A large-scale exercise is a more elaborate simulation of an emergency event that typically includes all the agencies and organizations that would be involved in a response in a particular area, such as a city, tehsil, or district. Typically, a hospital would participate in a large-scale exercise conducted by a government agency, but would not lead such an exercise. Large-scale exercises require detailed planning and coordination, but can be very effective in testing how various organizations will work together and identifying areas for improvement.

In order to stress the importance of drills, you can tell the story of Rick Rescorla, Security Chief for Morgan Stanley in the World Trade Center in New York. Because of his dedication to developing evacuation procedures and holding regular drills (every three months for everyone, even senior executives), all but a handful of Morgan Stanley's 2700 employees escaped unhurt when the World Trade Center was attacked on September 11, 2001. Mr. Rescorla ordered Morgan Stanley employees to evacuate, following procedure, after the first tower was hit (they were in the second tower). Tragically, Mr. Rescorla and three deputies died when the building collapsed while they were still trying to evacuate others.



Explain that the Incident Command System is a standardized, all-hazards emergency/event management framework that allows multiple organizations and jurisdictions to work together. ICS is a cost-effective and efficient way to handle both small and large events.

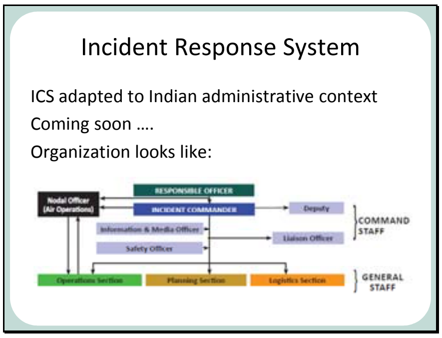
Because hospitals need special provisions for emergency response, there are special variations of the original ICS for hospitals; Hospital Incident Command System (HICS) is one of these. ICS has been widely adopted by hospitals in the US and Canada due to a Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requirement that hospitals use ICS in their emergency management programs. We recommend that you consider using IRS/ICS in your hospital.

ICS was developed to help better manage emergency responses, and to rectify some problems that plagued past responses to emergencies. These problems included communication difficulties, lack of accountability resulting from unclear lines of authority, and lack of an effective management structure to keep commanders from being overloaded. ICS has been tested and refined for over 30 years in events of all sizes.

ICS has a flexible, modular structure that expands and contracts as the incident changes in size or scope. The only position that is staffed in every event is the Incident Commander. Other positions are added by the Incident Commander as needed.

Note: the Incident Commander is not always the most senior person, but should always be the most knowledgeable and experienced person. The Safety Officer is a very important position (actually the most powerful person in the command structure): they can stop any activity if they deem it to be unsafe. The Safety Officer also monitors staff to detect fatigue, abuse and post-traumatic stress syndrome.

Tell trainees that this is only a brief introduction to ICS. The FEMA website has numerous resources for ICS training if they would like to learn more.



Explain that the Incident Response System is India's version of ICS. IRS is based on the Incident Command System (ICS), with adaptations to the Indian context (primarily the Indian administrative system). It is currently being rolled out in India; NDMA released guidelines in July 2010 and training of government officials will begin soon.

IRS has Indian administrative structures incorporated into it. Incidents will be handled through Incident Response Teams (IRTs) that are pre-designated at the state, district, and sub-district (tehsil and block) levels. Your hospital should eventually be contacted regarding its role in the appropriate IRT.

In addition to working with other agencies through IRS, the hospital will need its own emergency plan. This plan should be compatible with the IRS, though it may be simpler to start with basic ICS or HICS and adapt it directly to your hospital's needs.

IRS provides a single set of guiding priorities for your planning process.

Command and Control

- Unity of command
  - Clear
  - Creates accountability
- Transfer of command
- Span of control
  - Leader directly manages small number of resources
  - Optimal number in ICS is five; maximum is seven
  - ICS organizational structure expands and contracts as needed to maintain manageable span of control

Incident managers must consider command and control, and IRS/ICS is set up to make that simple and straightforward. ICS uses some basic concepts:

-Unity of command: There is one chain of command, with one position (Incident Commander) clearly and ultimately in charge. This creates accountability.

-Transfer of command: A transfer of command ALWAYS includes a transfer of command briefing. ICS anticipates the need to transfer command (there will be a day shift and night shift as the Incident Commanders need some sleep) and provides for it.

-Span of control: A very useful concept, manageable span of control says that a leader can only effectively manage a finite, small number of resources directly. Based on research, the optimal number of resources is five, with the maximum being seven. A resource could be a person or a team. If the number of resources under a particular person's control exceeds the manageable span of control, ICS has procedures to add organizational structure (like branches or groups) to maintain the span of control.

Security and Crowd Control

People will converge on the hospital. Security will:

- Control access
- Provide perimeter security
- Manage vehicle traffic at emergency entrance
- Facilitate entry of patients and triage
- Designate areas outside the hospital but within secured perimeter for family members and the media

Many different people will converge on the hospital:

-The injured and their family members, whether severely injured or "walking wounded"

-The "worried well"

- Spontaneous volunteers wanting to help

- Trained medical personnel from other facilities arriving as part of mutual aid agreements or requests from the hospital

- The media

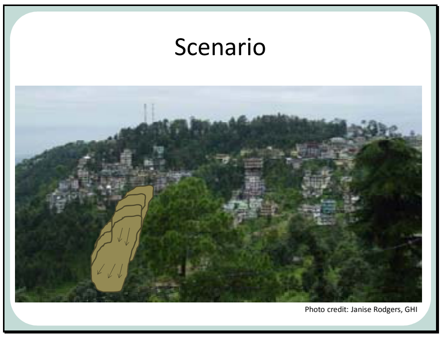
- Government officials and politicians (typically after the immediate crisis phase has passed)

In the phase immediately following the earthquake when numerous casualties are arriving, you will in all likelihood prevent almost all family members (except a parent accompanying a small child, for instance) or any other visitors from entering the hospital, to allow the medical staff to focus on treating patients. Designate an area for family members outside the hospital, but within the secured perimeter.

Communication is critical during a disaster. The hospital will need to communicate effectively with outside entities such as the families of patients, government agencies involved in the response, and the media. The hospital will also need to communicate within the organization. ICS/IRS provides staff positions within the command staff to handle these duties.

Providing accurate information and repeating consistent messages at timely intervals helps to reassure people and prevent rumors. Resources for communicating messages include the media, government and the military. In a major disaster, you will need to communicate with other hospitals and provide regular status updates to the government and/or international relief agencies working in your area (UN, Red Cross/Red Crescent, etc.).

Family members will be outside the hospital building, and you should set up a communication post outside but within the family area inside the secure perimeter to provide information to family members in an orderly manner. Security will help control the crowd.



Read/describe the following scenario (or a similar one appropriate for your local conditions) to the trainees:

It is the middle of the monsoon. A minor, local earthquake at 4 pm causes a rain-soaked hillside in the Himalaya foothills to collapse and cause a landslide. A town sits atop the hill, and the landslide moves the soil from beneath several buildings containing houses and shops, and causes them to collapse. The earthquake also causes tall and narrow items to topple in some of the town's other buildings.

The district hospital is about 15 km from the town where the landslide occurred. Fortunately, the road between the town and the hospital had been re-built six months ago with proper drainage and was not damaged by the landslide (or the monsoon rains, for that matter). People at the hospital felt minor shaking. Power and utilities remain functioning. The medical superintendent is out of station, on her way home from a conference in Delhi. The deputy medical superintendent, who is in charge in her absence, calls maintenace immediately and directs them to make a quick check for damage, even though the shaking was not strong and nothing in his office has been damaged. He and his office staff split up and do a quick walk-through of the hospital themselves to make sure no one has been injured (he leaves one person in his office to answer the phone). No one has; everyone took protective actions as they had been trained to do.

A few minutes later (at 4:05 pm), one of the emergency department doctors gets a call on his mobile from a friend in the town atop the hill, saying that there has been an landslide, several buildings have collapsed, and there are a number of people injured. The friend is just getting into a minibus taxi on his way to the hospital with some other injured people; his daughter has a badly broken ankle from a fall down the stairs while trying to run out of a building, and he has some cuts on his head from being struck by falling objects. He asks the doctor to contact the authorities for help in freeing some people trapped in the buildings collapsed by the landslide. He says that people are digging by hand but they need equipment.

The doctor immediately notifies the deputy medical superintendent that there has been significant damage in the town due to the landslide and that casualties are headed for the hospital. The deputy medical superintendent immediately activates the hospital’s emergency response plan, which utilizes IRS. He is the Incident Commander for the hospital. He directs the emergency doctor to prepare the emergency department to receive casualties, and designates him as Deputy Incident Commander. He appoints the medical superintendent’s assistant as Liaison Officer, and directs him to notify local authorities of the landslide and coordinate with the search and rescue team and authorities. The next shift of nurses is arriving, and the Incident Commander (the deputy medical superintendent) directs the current shift to remain at work as well to handle the incoming patients.

Ten minutes later (at 4:25), the head of facilities reports that they did not find any damage in the initial assessment of because highly vulnerable items had been anchored before the earthquake. The Incident Commander summons the security guard, and directs him to set up a security perimeter and family waiting area with help from the maintenance department now that the damage assessment is complete. The deputy medical superintendent calls the medical superintendent on her mobile and reaches her as she is nearing her home. He tells her what has happened and that he has activated the hospital’s emergency response plan. She promises to be there as soon as she can.

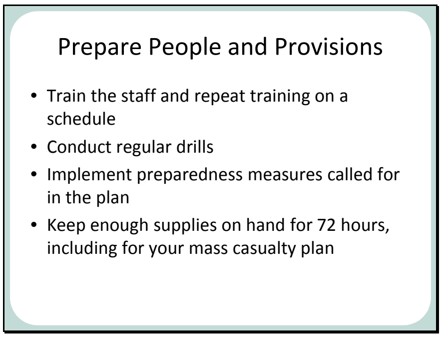
Thirty minutes after the earthquake (4:30 pm), casualties begin to arrive from the town. The emergency department is soon filled to capacity and beyond. An hour after the earthquake, the medical superintendent arrives at the hospital. After a transfer-of-command briefing, she takes over the role of Incident Commander from the deputy medical superintendent. Additional family members of the injured began arriving, and the medical superintendent appoints a Public Information Officer to set up an information desk outside to provide information to the families and to work with security to keep them from disrupting the work of the emergency department. Word of the earthquake has also reached hospitals in several nearby districts, who call to ask how they can help. (As the IRS rolls out in India, the process may change and become more formally routed through the Incident Response Team). The medical superintendent designates the emergency room doctor, currently the deputy incident commander, as Operations Section Chief to manage ongoing operations, the assistance arriving from these other hospitals, and potential patient transfers to other hospitals.

Ninety minutes after the earthquake, the Liaison Officer gets a call from the fire brigade requesting a medical team to assist several badly injured victims the brigade is currently trying to extract from the collapsed buildings. Since most of the patients in the ED have been stabilized, the Operations Section Chief sends an experienced trauma doctor and two nurses to the scene. The medical team assists in the extraction and arrives at the hospital an hour and a half later with three very badly injured victims, two of which had amputations in the field in order to free them. The patients are stabilized at the hospital. Three hours after the earthquake, the media begins to arrive in the area. The Information and Media Officer provides reporters with information on the number of injured and on the hospital's good seismic performance, and continues to provide family members with information.

Six hours after the earthquake (10 pm), all patients have been treated and admitted or discharged, and arrangements have been made to transfer the two patients with amputations to hospitals in Delhi (or the nearest big city for your area) that specialize in amputee care and rehabilitation. The transfer is scheduled to occur the next morning. The Operations Section Chief works with the Liaison Officer to identify the best sources for replenishing medical supplies; several nearby hospitals agree to send supplies over in the morning.

Sixteen hours after the earthquake, the hospital continues to provide care for the patients who have been admitted, and is very full. Several truckloads of medical supplies arrive from nearby hospitals to replenish the stocks.

Seventy-two hours after the earthquake, hospital operations return to normal, save for a heavier patient load due to a few earthquake victims who remain hospitalized.



Training is important – people need to know what to do. Staff need to be trained on life safety and response procedures, and in implementing the operational continuity/recovery plan. (There will not be time for training in the aftermath of a disaster.)

Also, “use it or lose it” applies to disaster preparedness too. If you don’t use your knowledge, you’ll forget. So, conduct regular drills and refresher courses, as well as providing training for new staff members.

We’ll talk about this more later, but the families of staff members will also need to be trained and prepared so that they can manage on their own while the staff member reports to work.

You can substitute your local jurisdiction’s recommendation for how long to remain self sufficient before help arrives for the 72 hours listed.

Mention any relevant resources for staff training.

Mitigate Risk

- Seismically retrofit building or replace with earthquake resistant new construction
- Anchor, brace and protect
- Have backup systems
- Obtain insurance

Photo credit: Hari Kumar, GHI

Summarize the broad classes of risk mitigation actions.

Mitigate risk based on the established hazard and risk assessment, and priorities to reestablish operations and delivery of services. The hospital's existing policy should define the hospital's mission, from which priorities for mitigation will be derived.

During an Earthquake

Photo credit: Hari Kumar, GHI

Drop, Cover and Hold On

People who are able should drop, cover, and hold on. People in hospital beds should remain in bed, curl into a ball lying down if possible and cover their head with a pillow. Staff should instruct patients and family members on what to do if possible, but should protect themselves so they will be able to provide care to many after the earthquake.

After an Earthquake

Put your plan into action!

- Help rescue/treat injured staff and patients
- Take protective measures
- Shut off leaking oxygen or gas if any nearby
- Be prepared for aftershocks
- Evacuate only if building is in danger of collapse or if patients can't be treated inside

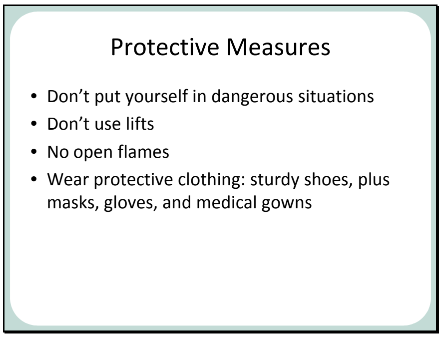
Put your emergency plan into action.

Survey the facility, and rescue and treat any patients or staff that have been injured

Take measures to protect yourself. You can't help if you get hurt.

Shut off any oxygen or gas that is leaking or nonessential to prevent fires and explosions.

Expect aftershocks, and avoid situations where an aftershock would put you in danger.
- Evacuate the building only if it has suffered severe damage and is obviously in danger of collapse, or if you can't treat the patients inside.



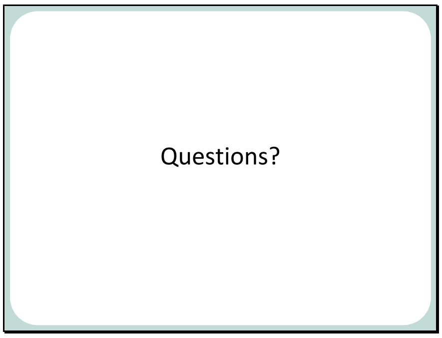
You will need to take some commonsense protective measures.

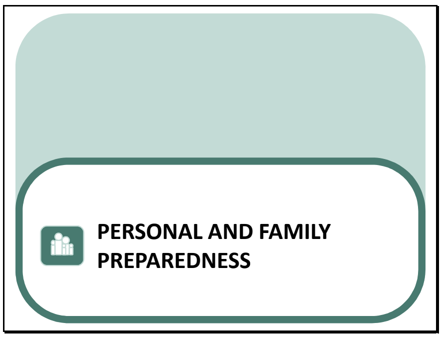
- Don’t put yourself in dangerous situations: if there may have been an hazardous materials release (i.e., in radiology), or simply walking across broken glass in inadequate shoes; there are many other examples you can give. You won’t be able to help if you become a victim.

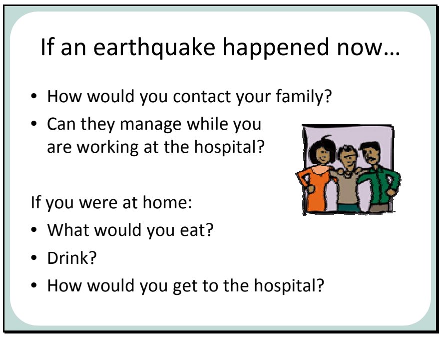
- Don’t use the lifts until they can be checked; lift systems can be vulnerable to earthquake damage unless they have special seismic protection measures in place

-Do not light matches, use lighters or candles, or have any open flames until all danger of gas leaks is past; otherwise there could be an explosion or fire

- Wear protective clothing: sturdy shoes to avoid injuries from broken glass, masks to keep out dust, and gloves and medical gowns for protection from bodily fluids



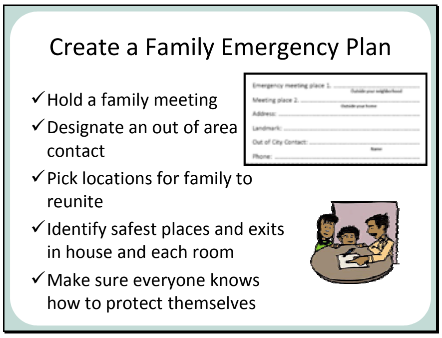




Ask trainees to think about these questions.

A hospital is an important facility that will have a crucial role immediately following an earthquake. You will not be able to go home immediately and check on the welfare of your family. Your family should be prepared, so that they can take care of themselves and help their neighbors.

If you are at home, you will need to go to the hospital to help treat patients. How will you get there?



Explain each bullet point in detail, and emphasize than many small steps can make a very big impact on your family's safety. If your family is prepared, you can help others.

-Hold a family meeting: Be sure all family members that live in your home attend, especially children and elders. If other family members live very close by, consider having a joint meeting with their families so you can coordinate your plans.

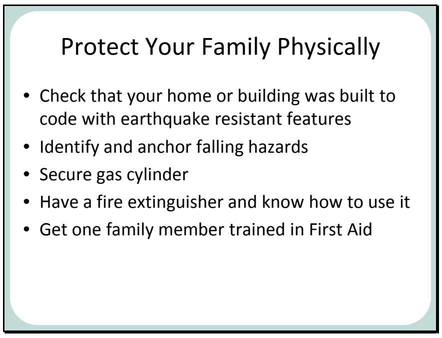
-Designate an out-of-area contact: Communication systems will be overwhelmed after a disaster. Do your part to lessen the load so those with true emergencies can get the help they need. Designate a person that does not live in your area and who has a mobile phone to be the one for your family and friends to call to find out about your family's well-being. Talk to that person and tell them about their role and what to expect. You will send them a short SMS to tell them that you are okay. Tell your friends and family members to call the out-of-area contact in the event of a disaster, and give them the mobile number.

-Pick locations for family to reunite: If the family is not together when the earthquake happens, they will need to reunite. You will be at the hospital – they will need to manage on their own. Mobile phone networks will be overloaded so you will need to designate a location beforehand. Select locations in your house, outside your house, and outside the neighborhood (in case access to your neighborhood is blocked).

Hand out cards with space to write meeting places and out of area contact.

- Identify the safest places in the house and in each room. These will be locations away from falling hazards, glass, or fire hazards; and preferably under a sturdy piece of furniture. Also identify the exits and alternative exits in each room. It will be helpful to walk from room to room and find the safest places and exits together. Children may not realize that windows are alternative exits.

-Make sure everyone knows how to protect themselves. Everyone should know what to do when the shaking starts. If inside, Drop, Cover and Hold On. If outside, move away from trees, power lines, buildings, or anything that could fall, and drop down. If driving, pull over and stop in a safe area away from flyovers, bridges, light and power poles, etc.



Explain the elements of physical protection:
-Building safety is the most important. Get help from a qualified engineer to determine if your building is safe or needs strengthening.

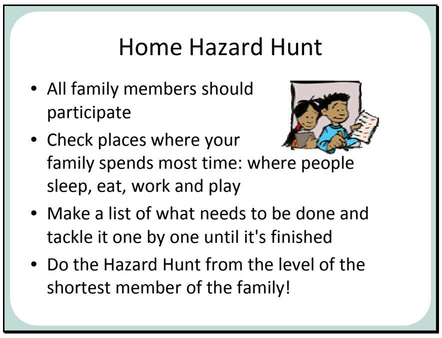
-Identify and anchor or relocate falling hazards. Pay particular attention to large and heavy items.

-Secure your gas cylinder to keep it from toppling and creating a fire hazard.

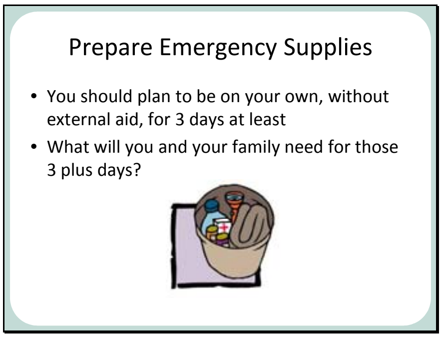
-Have a fire extinguisher and make sure everyone knows where it is and how to use it

-Have one member of your family get trained in first aid (remember, you will have to stay at the hospital – you don't count as the one member!)

Also, it's always a good idea to keep a pair of shoes and a torch (flashlight) by your bed, in case an earthquake happens during the night. The power is very likely to go out and you could injure yourself by stepping on broken objects or falling in the dark.



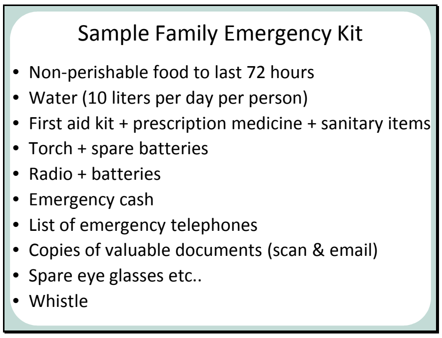
Ask trainees to conduct a home hazard hunt with their families. Very simple, low-cost anchoring solutions can prevent injuries and property damage.



Make sure that the time to plan to be on your own matches that for the jurisdiction where you are doing the training. The standard timeframe is 72 hours (3 days), but can be longer in rural or remote areas.

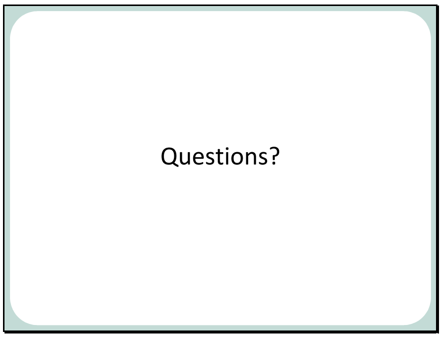
Write on a whiteboard or large pad of paper and have trainees tell you what they would need. Be sure they cover the following:
-Food
-Water
-Prescription medicines (especially those that are taken daily)
-Torch (flashlight) and battery
-First aid kit
-Cash
-Toiletries
-Special items for elderly, disabled, small children and animals

Hand out DDMA (or other) preparedness checklists.

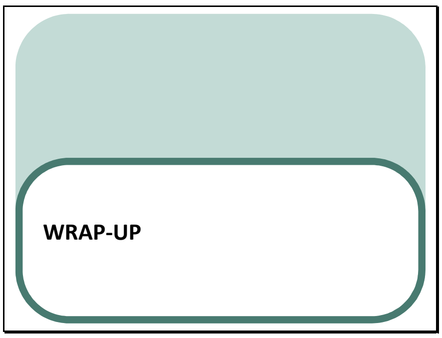


Explain that each family's kit will be different. This list is only indicative and should be a starting point to help them think of the things they will need. Explain that they should think of individual family members' needs when preparing the kit. If you have pets you will need to plan for their food and water as well.

Make trainees aware of any local training programs (i.e., put on by the Disaster Management Authority or Fire Service) that can help them be better prepared. Possibilities include training on the Incident Response System, fire safety, mass casualty management, disaster medicine, volunteer management, and basic search and rescue.



Answer any questions.



Today We Learned

- Why hospitals are at risk from earthquakes
- About earthquake basics
- About earthquake damage and consequences
- How to identify and mitigate risks
- About hospital emergency preparedness basics
- How to prepare ourselves and our families for an earthquake or other disaster

Review what we covered today (be brief!!):
Why hospitals are at risk – they contain complex systems, vulnerable people, and expensive equipment.

Earthquake basics - earthquakes have occurred and will continue to occur; how strong the shaking might be; be prepared for aftershocks;

Earthquake damage and consequences: damage to the building, systems and contents can cause loss of life, loss of function, loss of property/money, and loss of community confidence;

How to identify and mitigate risk: Look for things that can fall, slide or topple; consider objects as part of a system; look at manual for guidance on specific objects; keep in mind safety, functionality, and load path when developing and implementing seismic protection measures;

Hospital emergency preparedness basics: a hospital safety committee; the need for a plan and to test it with drills; incident command system;

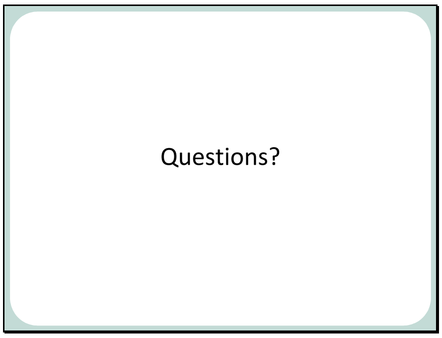
Personal and family preparedness: family emergency plan and kit; home hazard hunt.

Next Steps

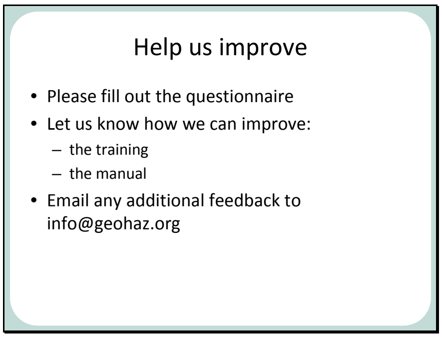
- Summary of next steps for project; will vary with situation

Here, you will explain what will happen next during the project. In most cases, you will work with the hospital to begin taking the steps toward earthquake safety that we learned about today: finding an engineer to assess the building, doing a hazard hunt, estimating costs and prioritizing, forming a hospital safety committee, beginning to implement mitigation measures, etc. Some hospitals may have already decided to pursue a more in-depth earthquake risk reduction program that includes structural retrofit (strengthening). Be sure to provide accurate information about the plans your hospital's administration has, and that you have their permission to discuss the planned actions with the staff. You may wish to have a hospital administrator explain the hospital's plans during the introduction to the training course, rather than here at the end.

Encourage the doctors to prepare a family emergency plan, so that their family can manage on their own while they stay at the hospital.

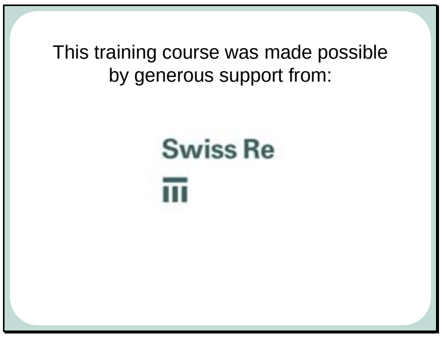


Answer any final questions.



Ask that trainees fill out the evaluation questionnaire to help improve the training course, and invite them to provide additional feedback to info@geohaz.org.

Thank everyone for coming.



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