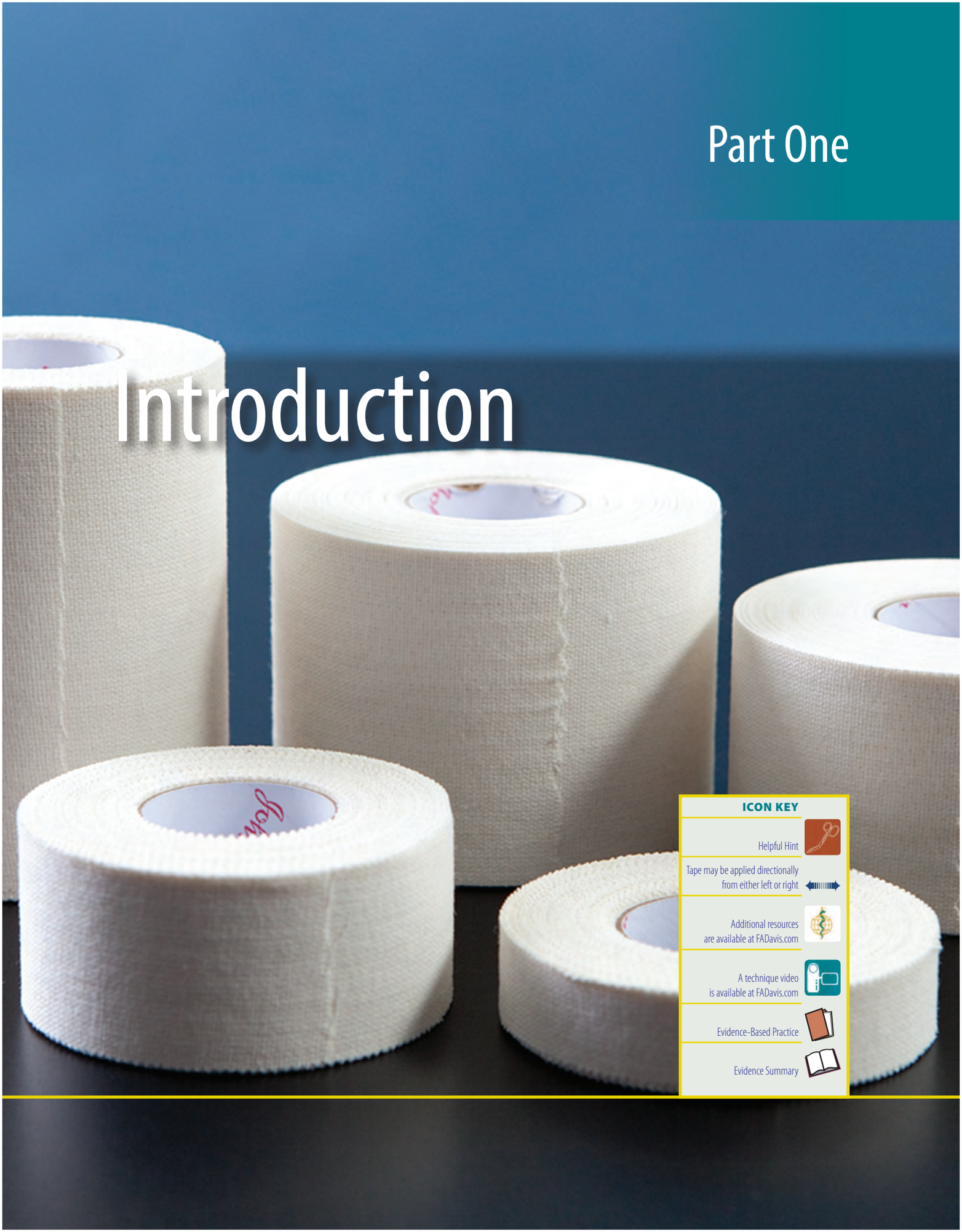
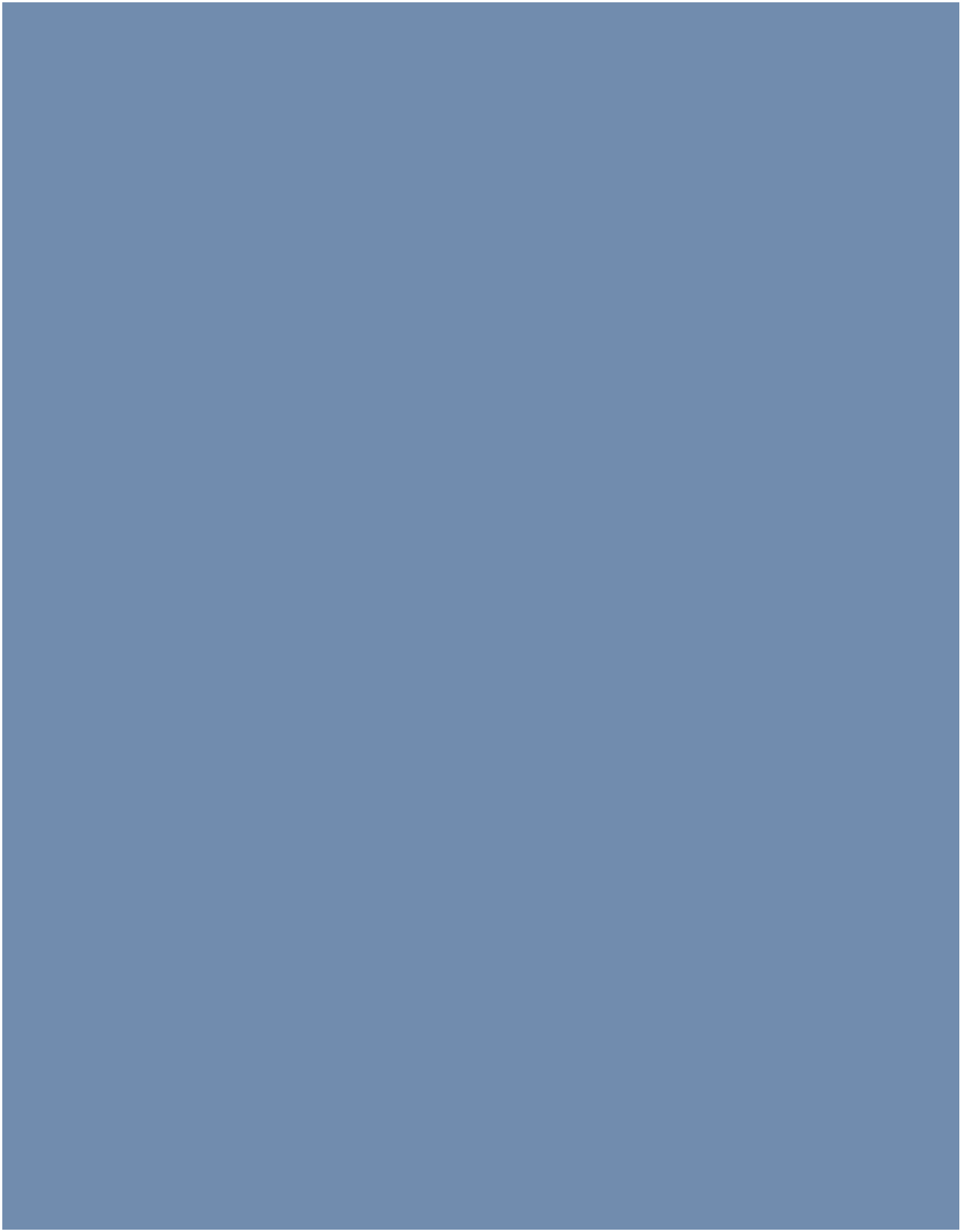
Part One

Introduction





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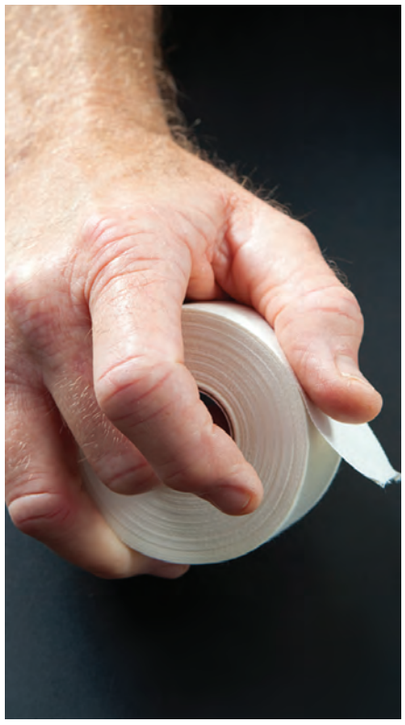

Tapes, Wraps, Braces, and Pads

LEARNING OBJECTIVES

1. Explain and demonstrate evidence-based practice and the process used to make clinical decisions for the implementation of taping, wrapping, bracing, and padding techniques into clinical practice.
2. Discuss and explain the types, objectives, and application recommendations for taping, wrapping, bracing, and padding techniques used when preventing, treating, and rehabilitating injuries.
3. Discuss and demonstrate the ability to select the appropriate types of tapes, wraps, braces, and pads used when preventing, treating, and rehabilitating various injuries.

Taping, wrapping, bracing, and padding techniques have been used for many years by health care professionals in the prevention, treatment, and rehabilitation of injuries. Athletic trainers, the health care professionals who typically apply the techniques, are skilled in technique application as a result of instruction and practice. For example, in a day, a typical athletic trainer (AT) may tape 20 ankles, wrap two hand contusions, apply three knee braces, and construct two protective pads. With appropriate didactic instruction in anatomy, biomechanics, injury evaluation, treatment, and rehabilitation, students can become proficient in the application of these techniques. In fact, practice may be the only hurdle to becoming proficient.

The application of taping, wrapping, bracing, and padding techniques should be implemented within the paradigm of evidence-based medicine (EBM). Evidence-based medicine is the integration of the best available research evidence with individual clinical expertise and patient goals, values, and preferences to make clinical decisions.[1] The evidence comes from patient-centered, clinically relevant research[2] on taping, wrapping, bracing, and padding interventions published in the scientific literature. Evidence is evaluated to determine its quality and value to day-to-day clinical practice. The evidence can support or refute previously accepted techniques or reveal new techniques that produce improved patient outcomes. Clinical expertise within EBM is the knowledge and proficiency in anatomy, biomechanics, injury evaluation, treatment, and rehabilitation, and taping, wrapping, bracing, and padding techniques. Clinical judgment is developed from clinical training, experience, and practice. Patient goals, values, and preferences are different among patients based on sport, occupation, lifestyle, and activity level. These must be identified and implemented into the practice of EBM.

The implementation of EBM into practice, or evidence-based practice (EBP), achieves several goals. EBP improves patient care, promotes critical thinking among clinicians, and advances the profession of athletic training.[2] EBP is a process of five progressive steps: (1) developing clinically relevant questions, (2) searching for the best evidence, (3) evaluating and appraising the evidence, (4) implementing the evidence into clinical practice with patients, and (5) evaluating the effects of interventions on patient outcomes.[1–3] Many of these steps require research training, knowledge, and skills;

large amounts of time; and financial and personnel resources to successfully complete. For a more detailed discussion of EBM and EBP, see the Further Reading section at the end of this chapter.

Clinical decision making and the prevention, treatment, and rehabilitation of injuries and conditions should be based on the available evidence, clinical expertise, and patient goals and values. Current research investigating the effectiveness of taping, wrapping, bracing, and padding techniques has overall produced a limited amount of evidence in the literature. While some techniques such as ankle taping and bracing and knee bracing have undergone study, many techniques lack any or sufficient investigation of their effectiveness on patient outcomes. The mere presence of evidence from studies does not necessarily mean the technique has been shown to be the gold standard as evidence differs in quality and applicability to clinical practice. Furthermore, expert opinion and clinical experience are often the only source of evidence to guide clinical decision making with taping, wrapping, bracing, and padding techniques.

Evidence, or research data, is produced from different sources, and a brief overview of the hierarchy of these sources can assist in determining the importance or strength of the findings and application to clinical practice. The highest level of evidence in the hierarchy comes from a meta-analysis followed by a systematic review. A meta-analysis uses statistical methods to combine and analyze data from clinical studies that meet pre-specified eligibility criteria to reach a conclusion as to the effectiveness of an individual treatment or technique. Systematic reviews comprehensively assess relevant studies on a topic and synthesize the findings into a qualitative summary of the evidence. Randomized controlled trials are studies that compare a randomly assigned experimental group (group that receives a treatment) with a randomly assigned control group (group that does not receive a treatment) using statistical methods to determine differences between the groups. Cohort studies compare two groups over time, a group that receives a treatment with a group that does not, to evaluate the effect of the treatment. Case-control studies look back in time and compare a group with a specific condition with a group without the condition to examine the differences among the groups. Case series are collections or reports of patients with a specific condition or who are receiving a specific treatment. Case reports are similar to case series but report on only one patient. Case series and case reports do not include a control group. Expert opinion is the lowest level of evidence and is based on opinions from authorities or expert communities, usual practice, or clinical experience.

DETAILS

Here is a quick look at the evidence hierarchy with simulated examples of study types or research areas. The highest level of evidence is a meta-analysis and the lowest level is expert opinion.

- Meta-analysis: A collection of 10 well-designed, similar studies examining the effectiveness of semirigid orthotics in reducing rates of plantar fasciitis among male and female intercollegiate basketball athletes.
- Systematic review: A comprehensive literature review of 50 studies investigating the effect of epicondylitis strap braces on grip strength among recreational tennis players with lateral epicondylitis.
- Randomized controlled trial: The effects of a lower leg neoprene sleeve on vertical jump height among healthy, female high school volleyball athletes randomly assigned to an experimental group (wearing neoprene sleeve) and control group (not wearing neoprene sleeve).
- Cohort studies: The effectiveness of a video-based instructional method in teaching taping techniques in five athletic training programs compared with five similar athletic training programs with traditional instruction (lecture and lab) over a 2-year period.
- Case-control studies: The effects of functional knee braces used prophylactically on side-to-side movements among a group of healthy, intercollegiate football linemen with two seasons of brace wear during practices and competitions compared with a group of healthy intercollegiate football linemen who do not wear the braces.
- Case series: A review of all medical records from Mason County High Schools with interscholastic soccer program(s) documenting the diagnosis of osteitis pubis among male and female athletes to characterize common mechanisms of injury.
- Case reports: The use of a unique taping technique in the treatment of gamekeeper's thumb in a high school lacrosse athlete.
- Expert opinion: "Always overlap tape by ½ of the width to avoid gaps and inconsistent layering."

The evidence hierarchy can be useful to help establish the importance of data findings or recommendations to clinical practice. In later chapters, "Evidence Summary" boxes will present relevant data from reviews and studies and accompany specific taping, wrapping, bracing, and padding techniques. Let us now look at a fictitious example of the EBP process and how clinicians can use the information for clinical decision making.

The fourth match yesterday of the varsity female soccer season was hectic for Sigmund Bass. Sigmund is an AT

at Beaver Orthopedic Clinic and performs outreach at SRT High School. The match was played in the rain at a regional park on a worn artificial turf field. The field was slick from the rain, and the athletes were having difficulty maintaining contact with their cleats on the turf. Over a span of 10 minutes in the second half, two midfielders sprinted to intercept separate passes. The midfielders attempted to stop quickly but lost their footing on the wet turf, falling on an outstretched arm and forcing their wrists into hyperextension. Just minutes later, the goalkeeper dove toward the inside post for a save and collided with an opponent, forcing her wrist into hyperextension. Several possessions later, the striker was moving toward the goal for a shot and was slide tackled by an opponent, falling to the turf, forcing her wrist into hyperflexion. Each athlete was removed from the match following her injury and evaluated and treated by Sigmund on the sidelines. The athletes did not return to the match.

Today, the team physician evaluates the athletes in her office. Radiographs demonstrate no bony pathology. The team physician diagnoses each athlete with a second-degree hyperextension or hyperflexion wrist sprain. Sigmund and the team physician develop a treatment program for each athlete and discuss various wrist taping and bracing techniques for the athletes to prevent further injury upon a return to activity.

Using their combined 40 years of experience with the application and use of wrist taping and bracing techniques among athletes, Sigmund and the team physician consider which technique to use with the soccer athletes. The development of a focused, **clinically relevant question** (Step 1) is needed to actually find an answer as to which technique is most appropriate for the athletes. Sigmund and the team physician developed the clinically relevant question, "Is taping or bracing more effective for soccer athletes with hyperextension or hyperflexion wrist sprains to provide support and protect from further injury during sport activity?" This question included the criteria of a focused, clinical question in the PICO format:[4,5]

The **P**atient population or **P**roblem: Soccer athletes with hyperextension or hyperflexion wrist sprains
The **I**ntervention: Taping techniques
A **C**omparison intervention (if relevant): Bracing techniques
The clinical **O**utcome of interest: Provide support and protect from further injury during sport activity

Sigmund returns to Beaver Orthopedic Clinic and enlists several colleagues to assist him in **searching for the best evidence** (Step 2) to answer the clinically relevant question. The group begins their search using electronic databases through the Internet in the Clinic and at the local university, which offers on-campus access to many subscription bibliographic databases. Some medical databases can be accessed free of charge while others require a subscription.

DETAILS

Electronic Databases for Evidence-Based Medicine

Free Access

Cochrane Library, http://www.cochrane.org/
MEDLINE/PubMed, http://www.nlm.nih.gov/bsd/pmresources.html
The Joanna Briggs Institute, http://joannabriggs.org/
PICO searching, http://pubmedhh.nlm.nih.gov/nlmd/pico/piconew.php
PubMed, https://www.ncbi.nlm.nih.gov/pubmed/
PEDro, http://www.pedro.org.au/
Centre for Evidence-Based Medicine, http://www.cebm.net/
Google Scholar, http://scholar.google.com/
Agency for Healthcare Research and Quality, http://www.ahrq.gov/
Bandolier, http://www.bandolier.org.uk
BMJ Evidence-Based Medicine, https://ebm.bmj.com/

Subscription-Based Services

CINAHL Complete, https://www.ebsco.com/products/research-databases/cinahl-complete
SPORTDiscus, https://www.ebsco.com/products/research-databases/sportdiscus
DynaMed Plus, https://dynamed.com/home/
ProQuest Health and Medicine, http://www.proquest.com/libraries/academic/health-medicine/
Taylor & Francis Online, http://www.tandfonline.com
ScienceDirect, http://www.sciencedirect.com
eBook Collection, https://www.ebscohost.com/ebooks/academic/subscriptions/academic-ebook-subscriptions

Based on Sigmund's clinical question, the group searches each database with specific search methods to retrieve the best matched studies and reviews. The individual search terms or combination of terms they use for the databases include wrist taping, wrist bracing, wrist support, wrist guards, wrist soccer injuries, wrist sprains, wrist injury treatment, wrist hyperflexion, wrist hyperextension, randomized controlled trials, meta-analysis, systematic review, randomized trial, clinical trial, double blind, single blind, and case report. The group uses additional criteria to further narrow the number of results obtained from the searches to those

most relevant. The group limits the search to studies that are randomized controlled trials or quasi-randomized controlled trials, were published in the last 7 years, have participants 12 years of age and older, and are published in the English language.

The search is performed over several weeks and produces 30 possible references for the group to review. Most of the electronic databases only provide article citations while others include an abstract with the citation. The databases at the local university produce several full text complete articles. The group meets and discusses the retrieved citations, abstracts, and full text articles to again narrow the studies to those most relevant based on the clinical question and selection criteria. This review produces a list of 11 studies, and full text articles are obtained at the university by photocopying from journals, interlibrary loan services, and free web access to journals.

Sigmund, the team physician, and the group are now tasked with **evaluating and appraising the evidence** (Step 3). Each study is evaluated to determine its value to clinical practice. This step requires the most judgment in the EBP process.[2] Several rating scales are available to quantitatively evaluate individual studies, but many require research training and experience.

DETAILS

For more complete information on rating scales, see the Further Reading section at the end of this chapter.

Because of their limited training and experience with formal rating scales and quantitative methods to evaluate the evidence, the group instead asks three questions[3] of each study during the appraisal. The first question is "Are the results of the study valid?" The study results should be truthful, demonstrated through well-designed methodology of the study described in the text. Next, "What are the actual results?" The results should be reliable; when used in clinical practice, similar outcomes are produced. Last is "Are the findings clinically relevant to my patients?" The findings should be applicable and important to the patient population, high school female soccer athletes.

The group completes the evaluation and appraisal in several meetings and determines that the 11 studies are valid, reliable, and clinically relevant at different levels to the high school soccer athletes. Among the 11 studies, six are well-designed randomized controlled trials (RCTs) conducted in university research laboratories with non-athletic and athletic subjects. These studies examined the effects of various wrist taping and bracing techniques on active flexion and extension. The six studies demonstrated that taping techniques were significantly favored (reduced greater flexion and extension) over bracing techniques. Two separate studies comparing wrist taping and bracing techniques examined injury rates among intercollegiate football athletes. The incidence of wrist injury was significantly reduced over a competitive season with the use of bracing techniques compared with taping techniques. A small study examined the cost-effectiveness of wrist taping and bracing techniques among athletes with sprains in various sports at eight high schools. Over a 2-year period, the findings revealed that the use of bracing techniques was cost-effective compared with taping techniques in the treatment of wrist sprains. Two case reports found that a novel wrist bracing technique was subjectively rated as superior by professional ice hockey athletes with a sprain for comfort, ease of use, and protection (reduction in flexion and extension) during practices.

Sigmund and the team physician meet to discuss **implementing the evidence into clinical practice with patients** (Step 4). Evidence, clinical expertise, and patient goals, values, and preferences should determine the selection of the taping or bracing intervention for the soccer athletes. The evidence from the six RCTs supported the use of taping techniques to reduce wrist flexion and extension. Other evidence from three studies demonstrated that bracing techniques reduced rates of injuries and were cost-effective compared with taping techniques. The case reports produced favorable results for patient satisfaction with a new bracing technique. Based solely on the evidence hierarchy, it appears taping techniques should be used with the athletes. Sigmund and the team physician have numerous years of experience with wrist taping and bracing techniques. The team physician has seen very positive patient outcomes with bracing techniques in treating wrist sprains, and Sigmund is proficient in the application of taping techniques. However, Sigmund will not travel to the five away matches remaining in the season, and the budget for purchasing additional taping supplies is limited. The goal of the taping or bracing intervention for the athletes is to provide stability and protection and limit excessive wrist flexion and extension. The taping or bracing intervention needs to be easy to apply, adjust, and remove, comfortable to wear, lightweight, and comply with sport association rules. Based on Sigmund's experience, he believes the soccer athletes will prefer a bracing technique. Sigmund and the team physician carefully examine the evidence, their clinical expertise, and the patient population and decide to use bracing techniques to protect the injured midfielders, goalkeeper, and striker from further injury. The athletes are progressing well in the treatment program. They are fitted with functional wrist braces and instructed on their use as they begin functional activities on the field.

Sigmund closely follows the athletes during the final stages of their treatment program as they progress back into activity, **evaluating the effects of interventions**

on patient outcomes (Step 5). With 2 weeks of brace wear and a full return to practices and competitions, the athletes report to Sigmund that the braces are easy to apply and adjust, comfortable to wear, and lightweight in construction. The athletes state the braces provide stability and increase their confidence in performing at pre-injury levels. The athletes continue to wear the braces and finish the soccer season without further injury.

At the conclusion of a clinical case such as the previous example, an evaluation of the EBP process should be conducted by asking if the clinical question was answered, by asking if quality evidence was located in a timely manner, by asking if the evidence was appropriately evaluated, and by asking if integration of the evidence, clinical expertise, and patient goals, values, and preferences produced an acceptable clinical decision.[4]

DETAILS
For more detailed discussion of outcomes assessment, see the Further Reading section at the end of this chapter.

In this case, Sigmund was able to use EBP to find and apply an appropriate intervention for the injured soccer athletes. Faced with a unique situation, Sigmund and his group created a clinically relevant question to guide the search for an answer. The evidence search was conducted with specific terms and criteria in medical databases to focus on relevant studies and reviews for the clinical question. The group evaluated the evidence to determine its usefulness and application to the clinical situation. Although the evidence demonstrated support for both taping and bracing techniques, the strongest evidence from the six RCTs suggested that taping techniques were the appropriate intervention for the soccer athletes. However, other evidence supporting bracing techniques and the clinical expertise of Sigmund and the team physician, goal of the intervention, and needs of the athletes were integrated in the clinical decision to use a bracing intervention. An evaluation at the completion of the season demonstrated that the clinical outcome, no further injury of the wrist among the athletes, was achieved.

TAPES

The use of tape in preventing, treating, and rehabilitating injuries and conditions has been and continues to be popular with health care professionals. Intercollegiate and professional sport medical staffs often allot large proportions of their budgets to tape and associated supplies necessary for application. Many different types of tape are available. The decisions regarding which type to purchase and use should be based on the desired objective of the technique.

Types

Tapes fall into three main categories: non-elastic, elastic, and cast (Fig. 1–1). Non-elastic and elastic tapes have an adhesive backing that can adhere directly to the skin and other materials.

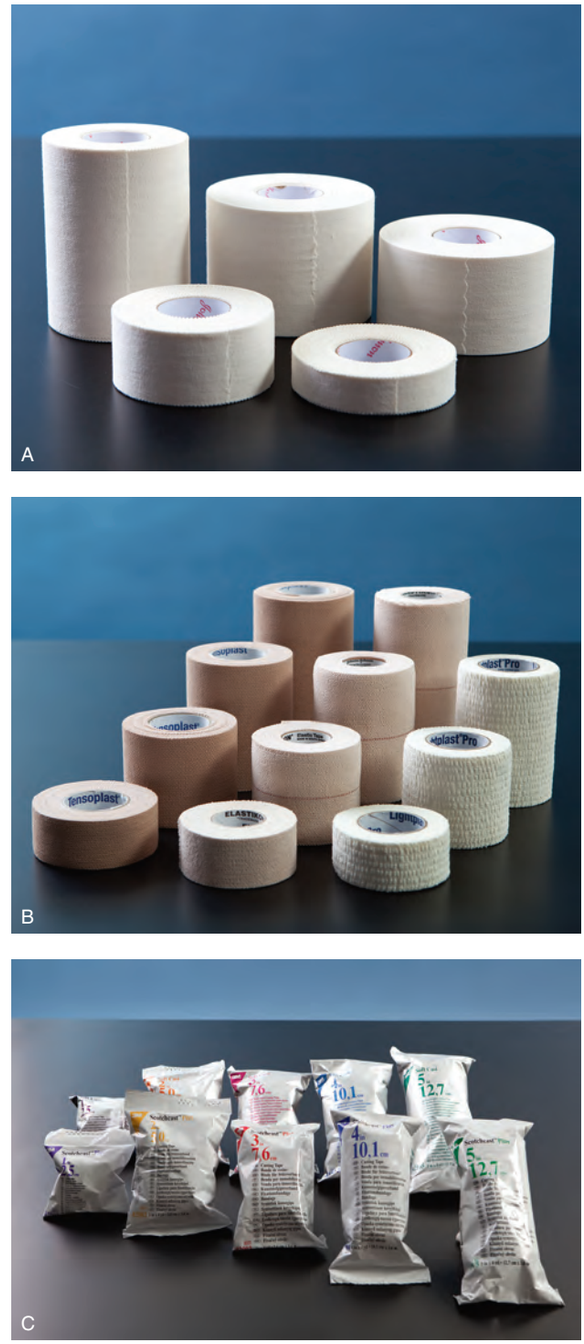

Fig. 1–1 **A** *Variety of non-elastic tape.* **B** *Variety of heavyweight and lightweight elastic tape.* **C** *Variety of semirigid and rigid cast tape.*

Non-Elastic

As the name implies, non-elastic tape does not possess elastic properties, so conformability to body contours can be difficult. Non-elastic tape is manufactured in a variety of sizes and colors. The most commonly used is white, which is available in ½, 1, 1½, 2, and 3 inch widths by 10 to 15 yard lengths (see Fig. 1–1A).

Non-elastic tape is made of cotton and/or polyester with a zinc oxide adhesive mass backing. Some types possess a high adhesive backing designed for application directly to the skin. The number of longitudinal and vertical fibers per inch in the backing determines the quality of the tape.[6] High-quality tapes have 85 or more longitudinal fibers and 65 vertical fibers per square inch; lesser-quality tapes have 65 or fewer longitudinal fibers and 45 vertical fibers. The quality of the tape will determine the amount and durability of the adhesive backing and the roll tension. The adhesive mass should be of a quality to withstand moisture, perspiration, and body and joint movements of the patient and to allow for easy removal. High-quality tapes typically possess the greatest amount of adhesive backing. Roll tension refers to how the tape comes off the roll. The tension ideally should be even and fluid when removing the tape from the roll.

Elastic

Elastic tape, commonly referred to as stretch tape, is manufactured in heavyweight and lightweight designs. The tape is available in 1, 1½, 2, 3, and 4 inch widths by 5 yard length in two commonly used colors: white and tan (see Fig. 1–1B).

Elastic tape is made of twisted cotton with an adhesive backing. The quality of elastic tapes is determined in a fashion similar to that for non-elastic tapes. The heavyweight tape is thicker than the lightweight design and provides more tensile strength and support when applied to the body. Several of the heavyweight designs require taping scissors to cut the tape from the roll during technique application. Elastic tapes have the ability to conform to the contour of the body while providing support.

Cast

Unlike non-elastic and elastic tapes, cast tape is a fiberglass fabric containing a polyurethane resin that reacts to water and air, causing a chemical reaction. This reaction makes the fiberglass set, or become hard. The tape is manufactured on a roll in semirigid and rigid types and is available in 1, 2, 3, 4, and 5 inch widths by 4 yard length (see Fig. 1–1C). Semirigid tape provides support while allowing range of motion of the body parts; rigid tape provides complete immobilization. Both types conform to the contour of the body. Taping scissors are needed to cut cast tape.

Objectives of Taping

Use taping techniques to:

- Provide support and reduce range of motion in preventing injuries
- Provide support and reduce range of motion in treating and rehabilitating existing injuries
- Secure elastic wraps when preventing, treating, and rehabilitating injuries
- Secure pads in preventing and treating injuries
- Secure dressings in treating wounds

Recommendations for Tape Application

Applying tape is more than simply "placing the sticky side down." The following recommendations will assist in effectively applying taping techniques.

Preparation of the Patient

Clean and dry the skin of the patient. Body oils from perspiration, lotions, and dirt/grass will lessen the adhesive properties of the tape. In some cases, shave the body hair over the area for effective application and removal of the tape. The position of the patient during application is important. As a general rule, when applying non-elastic and cast tapes, position the joint in the range of motion in which the joint will be stabilized. The position of the joint when applying elastic tape will vary because of the stretch qualities of the tape. There are exceptions to these rules, which will be illustrated in subsequent chapters.

Tearing Tape

Learning how to tear non-elastic and elastic tapes is the first step in becoming proficient in technique application. There are many methods to tear tape, but all have two commonalities: becoming comfortable with a method and practicing it to become efficient. A description of one successful method follows; it can be altered to accommodate individual preference (Fig. 1–2).

Practice this method to become proficient at tearing all sizes of non-elastic tape. Without this skill, smooth and efficient application of non-elastic tape will not be possible. The roll of tape should remain in one hand during application in order to avoid the time it would take to set the tape down and pick it up again repeatedly.

The ability to tear most sizes of lightweight elastic tape should come with skill in tearing non-elastic tape. The ability to tear heavyweight elastic tape requires experience and variation of hand and finger positions on the roll (Fig. 1–3). Do not become overly concerned if tearing heavyweight elastic tape is difficult; most health care professionals use taping scissors to cut heavyweight elastic tape during application. If the position of the patient

STEP 1: Hold the roll of non-elastic tape in one hand. Place the third finger of the hand through the roll to provide stabilization (see Fig. 1–2A). The roll should rest on the **proximal** phalanx of the finger and slightly on the palm.

Fig. 1–2 A

STEP 2: Place the tape extending from the roll between the tips of the thumb and second finger (see Fig. 1–2B).

Fig. 1–2 B

STEP 3: With the thumb and second finger of the other hand, hold the extended tape between the fingertips in close proximity to the fingers of the first hand (see Fig. 1–2C).

Fig. 1–2 C

Steps Cont.

STEP 4: Following this placement, pull both hands in straight, opposing directions with a slight downward motion (see Fig. 1–2D). Pressure on the fingertips with this movement will begin to tear the horizontal fibers of the tape.

Fig. 1–2 D

STEP 5: As the tape begins to tear, quickly **supinate** the hand holding the roll and **pronate** the other hand in a tearing motion (see Fig. 1–2E). The hands will rotate in opposite directions. Avoid twisting or crimping the tape. With practice, these two movements become synchronized into one movement.

Fig. 1–2 E

allows, have him or her cut the tape with scissors during technique application. This procedure will lessen the application time and will involve the patient in the technique.

Helpful Hint |
Hold the roll of elastic tape in one hand without placing a finger through the roll (see Fig. 1–3A). Instead of placing the extended tape between the fingertips of the thumbs and second fingers, grasp the tape between the distal thumbs and second, third, fourth, and fifth fingers of each hand (see Fig. 1–3B). The fingers will push the tape into the palms of the hands. Pull the tape tight to remove the elastic properties and rotate the hands in opposite directions (see Fig. 1–3C). As the hands rotate, use the forearms and upper arms to assist with the rotating movement.

Application of Non-Elastic and Elastic Tape

These general recommendations will guide the application of non-elastic and elastic taping techniques (Fig. 1–4). Individual variations of the techniques are presented in each chapter.

Once the patient is positioned on the taping table or bench with the skin clean and dry, begin the taping technique. Decide whether non-elastic or elastic tape will be applied directly to the skin or over pre-wrap. Applying tape directly to the skin will provide the greatest support but may cause skin irritation with daily use. Regardless of which method is used, applying adherent tape spray prior to taping should lessen migration of the tape (see Fig. 1–4A). Pre-wrap is a thin, porous foam material wrapped on 3 inch rolls (see Fig. 1–4B). Apply one layer of the wrap in an overlapping fashion, covering the body area.

Fig. 1–3

Fig. 1–4

Tape techniques applied over bony prominences and high-friction areas should receive extra attention. Use thin foam pads on the heel and lace areas with ankle and foot techniques. For patients who require daily taping, provide additional protection by using skin lubricants and foam pads. Use thin foam pads over bony prominences and high-friction areas to reduce irritation, which can lead to cuts or blisters of the skin (see Fig. 1–4C).

As previously mentioned, the objective of the technique and the size of the patient will dictate the type of the tape to use. Non-elastic tape does not have elastic properties and will adhere to the body at the specific angle in which the tape is applied. Non-elastic tape also provides more stability than elastic tape. Applying non-elastic tape over body contours can be difficult, however, especially with small joints. With practice and experience, the correct angles of application will be obtained. Do not force non-elastic tape to fit body contours. Place non-elastic tape over the belly of a muscle carefully to avoid causing constriction. Focus attention on restricting range of motion affecting normal body movements such as gait. In these cases, use elastic tape to provide support while allowing normal body movement.

Allergic reactions and trauma to the skin can occur when tape is applied. A reaction to taping materials, such as adherents or zinc oxide, can appear immediately or days following contact. Redness, swelling, and itching may indicate an allergic reaction. In this situation, protect the area from further injury and treat accordingly. If taping materials are shown to be the cause, discontinue their use. Replace the closed basketweave technique (see Fig. 4–4), for example, with a lace-up ankle brace (see Fig. 4–15) to limit inversion, eversion, plantar flexion, and dorsiflexion until the skin is asymptomatic. Refer the patient to a physician if symptoms persist.

Blisters and lacerations are often the result of gaps, wrinkles, and inconsistent roll tension during application. Proper management of the wound includes cleansing, debridement, and dressing. If the wound is open, maintain an environment optimal for healing (moist, clean, warm).

DETAILS

For more complete information on the management of blisters and lacerations, see the Further Reading section at the end of this chapter.

Use foam, felt, lubricants, or hydrogel pads to protect a blister or laceration during tape application. Apply these materials over the wound dressing. Cut a felt or foam donut pad (see Fig. 3–26) to lessen the amount of stress and impact over the wound. Applying skin lubricants either under or over a donut pad to further reduce friction is possible. Hydrogel pads may also be applied to reduce friction. Use adhesive gauze material (see Fig. 3–15) to attach the pad to the skin.

Follow these recommendations when applying non-elastic and elastic tapes:

- Gather the equipment and supplies needed (which may include adherent tape spray, pre-wrap, taping scissors, and various tapes, wraps, and pads) prior to beginning technique application.
- As a general rule, each technique begins and ends with anchor strips.
- To avoid gaps, overlap each strip of tape by at least ½ of its width.
- To avoid wrinkles, smooth each strip of tape with the fingers or hands as it is applied.
- Avoid gaps, wrinkles, and inconsistent roll tension, which may lead to skin irritations such as cuts and blisters.
- Follow the sequence of strips in each technique, avoiding multiple wraps or turns around a muscle or joint.
- Exercise caution when applying tape on patients with broken skin, rashes on the skin, or known allergies to taping materials.

DETAILS

Use non-elastic and elastic tapes of ½ and 1 inch widths by 5 and 15 yard lengths on the foot, toes, hand, and fingers; 1½, 2, and 3 inch widths by 5 and 15 yard lengths on the ankle, lower leg, knee, thigh, hip/pelvis, upper arm, elbow, forearm, wrist, hand, and fingers; and 3 and 4 inch widths by 5 and 15 yard lengths on the knee, thigh, hip/pelvis, shoulder, upper arm, elbow, chest/abdomen, and spine.

Helpful Hint |

If ½ inch or 1 inch non-elastic or elastic tapes are not available, create a roll from 1½ inch or 2 inch non-elastic or 2 inch elastic tape. Begin a longitudinal tear down the extended end of the tape at the desired width. Continue to tear this strip around the roll one time, leaving the other strip anchored on the roll. Strips in the same (¾ inch or 1 inch) or different (½ inch and 1 inch) widths on the same roll of non-elastic and elastic tapes may be made.

Application of Cast Tape

Rigid cast tape is normally applied by an orthopedic technician or physician following acute fractures. Application guidelines for rigid casting are beyond the scope of this text and can be found elsewhere. Semirigid tape, on the other hand, is used by many health care professionals when total immobilization is not required. The objective of the technique and size of the patient will determine the type and width of tape to use. In the athletic setting, semirigid tape is often used to provide support and protection when treating various injuries. The use of semirigid tape may be restricted based on state credentialing and scope-of-practice laws. Athletic trainers should carefully review applicable state practice acts prior to applying semirigid tape.

Applying cast tape requires several pieces of equipment: gloves, taping scissors, water, self-adherent wrap, stockinet, or padding material. Position the patient on the taping table or bench.

Generally, cast tape is applied over stockinet and soft cast padding, Gore-Tex padding, or self-adherent wrap. Apply the cast tape over one layer of stockinet placed directly on the skin and covered with two to three layers of soft cast padding material. This technique is commonly used with rigid tape techniques that require extended periods of wear. Protect the padding material under the cast tape from excessive moisture to prevent skin **maceration** and itching. An alternative to use with rigid tape is a Gore-Tex cast padding, which repels water, allowing any type of water activity, including bathing. Moisture underneath the cast tape evaporates, and the skin dries completely. In the athletic setting, apply three to four layers of self-adherent wrap underneath semirigid cast tape to allow reuse of the cast on removal.

Applying semirigid cast tape requires experience and skill (see Fig. 11–17). The following recommendations apply to cast tape techniques:

- Wear examination or surgical gloves coated with petroleum jelly or silicone to protect the hands from tape resin and to prevent the tape from adhering to the gloves during application.
- Open the sealed foil pouch and remove the roll of tape. Most rigid and semirigid tapes require immersion in water of 70° to 75°F to begin the chemical reaction. Firmly squeeze the roll three times while submerged. Approximately 3–5 minutes is allowed to apply, mold, and shape the tape before setting occurs.
- Apply the tape in a spiral or circular pattern with slight roll tension.
- Overlap each layer by ⅓–⅔ of the width of the tape. The number of layers applied will determine the amount of support.
- Avoid gaps, wrinkles, inconsistent roll tension, and direct contact of the tape with the skin to lessen irritation.
- Use taping scissors to make partial cuts in the material to fit the contours of the body. Pad bony prominences to lessen the occurrence of irritation.
- Place the last 8–12 inches of tape on the body without roll tension. Smooth and mold the tape to the body part with the hands to achieve adhesion of the layers.
- Approximately 10–15 minutes after removal of the tape from its pouch, curing is complete.

DETAILS

Use cast tape of 1 inch width by 4 yard length on the toes and fingers; 2 inch width by 4 yard length on the foot, ankle, forearm, wrist, and hand; 3 inch width by 4 yard length on the ankle, lower leg, upper arm, elbow, and forearm; 4 inch width by 4 yard length on the ankle, lower leg, knee, thigh, hip/pelvis, shoulder, upper arm, elbow, chest/abdomen, and spine; and 5 inch width by 4 yard length on the ankle, knee, thigh, hip/pelvis, shoulder, chest/abdomen, and spine.

Removing Tape

Removing tape can cause injury to the patient and should be performed in a controlled manner.

Non-Elastic and Elastic

There are several ways to remove non-elastic and elastic tapes (Fig. 1–5).

- Manually, remove the skin from the tape in a direct line with the body.[7]
  - One hand grasps the tape and pulls it across the skin while the other hand pulls the skin in the opposite direction (see Fig. 1–5A). Do not rip the tape from the skin.
- Tape removal solvents in spray or liquid forms work as well.
  - Apply the solvent between the skin and tape to dissolve the adhesive (see Fig. 1–5B).
  - Thoroughly wash the area and monitor for possible skin reactions to the chemicals.
- Taping scissors and cutting tools used for removal allow patients to perform the task themselves. Taping scissors are designed with a blunt end to reach under the tape and reduce the chance of damage to the skin[7] (see Fig. 1–5C). Tape cutters are molded plastic tools with a single-edged metal blade located at the end (see Fig. 1–5D). These tools fit into the hand and also have a blunt end. Purchase replacement blades for tape cutters as needed.

Fig. 1–5 A *Removing skin from tape.* **B** *Liquid tape removal solvent.* **C** *Taping scissors. (Top) Single ring. (Middle) Double ring. (Bottom) Heavy duty.* **D** *Tape cutters.* **E** *Removing tape with cutters.* **F** *Cast saw.*

- To remove tape, slip the blunt end of the scissors or cutter under the tape and cut in a **proximal-to-distal** direction away from the body. Keep the scissors or cutter parallel to the skin, following the contour of the body and avoiding bony prominences (see Fig. 1–5E).

Cast

Remove semirigid cast tape with taping scissors or a cast saw and spreaders or by unwrapping. Rigid tape requires the use of a cast saw, cast spreaders, and scissors (see Fig. 1–5F). Guidelines for cast saw use can be found elsewhere. Exercise care when operating a cast saw.

Fig. 1–6 **A** *Variety of elastic wraps.* **B** *Variety of elastic sleeves.* **C** *Variety of self-adherent wrap.* **D** *Cloth wrap. (Left) Individual wrap. (Right) Roll.*

Clinical Application Question 1

During football practice, several players begin to complain of a burning sensation over the **posterior** heel area. Prior to practice, you applied a preventive taping technique to their ankles. You remove the tape and discover irritation of the skin over the posterior heel of each player.

➠ **Question: How can you treat and prevent skin irritation?**

. . . IF/THEN . . .

IF the scissors or cutter cannot be easily placed between the tape and skin, **THEN** apply a skin lubricant to the blunt end of the scissors or cutter to assist in cutting the tape in tight areas.

WRAPS

Wraps are used for a variety of purposes and can be reused for multiple applications. Similar to tapes, many different types of wraps are available; their use should be based on the objective of the technique.

Types

Wraps, similar to tape, can be divided into three basic types: elastic, self-adherent, and cloth (Fig. 1–6).

Elastic

Elastic wraps allow for adjustments of compression during application. These wraps also conform well to body contours, providing multidirectional compression. Use Velcro fasteners, metal clips, or tape to anchor the wraps. Wash and dry elastic wraps after each use and reuse them. Similar to elastic wraps, elastic sleeves provide compression to the extremities. No additional anchor is required. Elastic wraps are made of cotton, rubber latex, or nylon in white and tan provided in 2, 3, 4, and 6 inch widths by 5 yard length and in 4 and 6 inch widths by 10 yard length (see Fig. 1–6A). The sleeves are made of cotton and rubber latex in 2, 2½,

3, 3½, 4, 5, 6, 7, and 8 inch widths by 11 yard length (see Fig. 1–6B).

Self-Adherent

Self-adherent wraps have elastic properties and the ability to adhere to themselves without irritation to hair or skin. These wraps come in a variety of colors and tear manually. Self-adherent wraps conform to body contours easily and provide adjustable compression. The wraps are intended for single use. Made of elastic yarn, they are available in 1, 1½, 2, 2¾, 3, 4, and 6 inch widths by 6 yard length (see Fig. 1–6C).

Cloth

Cloth wraps, referred to as ankle wraps, are made of strong cotton weaves in a 2 inch width by 36 or 72 yard length roll. Cut individual wraps in 72–96 inch lengths from the roll (see Fig. 1–6D). Use cloth wraps in a **prophylactic** manner to prevent medial and lateral ankle sprains. The wraps provide mild support. Wash and dry cloth wraps after each use and reuse.

Objectives of Wrapping

Use wrapping techniques to:

- Provide compression to reduce effusion and swelling when treating and rehabilitating injuries
- Provide support and reduce range of motion when preventing, treating, and rehabilitating injuries
- Secure pads when preventing and treating injuries
- Secure dressings when treating wounds

Recommendations for Wrap Application

The following recommendations apply generally to all wrapping techniques.

Preparation of the Patient

The objective of the wrapping technique will determine the position of the patient. For example, when applying a wrap over a muscular area, have the patient sustain muscular contraction during the technique to lessen the chance of constriction. To provide support and reduction in range of motion, position the joint in the range of motion in which the joint will be stabilized. Because wraps do not possess adhesive properties, wraps may be applied directly to the skin or, for cloth wraps, over socks.

After determining the technique objective and positioning the patient, choose the appropriate type of wrap.

Application of Elastic Wraps

Elastic wraps have the potential to cause injury and should be used with care. Improper application can cause impairment in circulation, abnormal accumulation of swelling or effusion, or irritation of the skin. Use these recommendations for assistance when applying elastic wraps.

- Apply elastic wraps with firm, constant tension.
- Overlap each successive turn of the wrap by ½ its width while being careful to eliminate gaps, wrinkles, and inconsistent roll tension, which may cause skin irritation.
- Apply compression wrap techniques in a **distal-to-proximal** sequence to assist in venous return (see Fig. 3–17). Never cover the **distal** aspects of the extremities with the wrap. Keep the tips of the fingers and toes visible and monitor for impairment of circulation.
- Anchor elastic wraps with Velcro fasteners, metal clips, or non-elastic or elastic tapes.
- Place the end of the wrap and anchor on the dorsal or **anterior** aspect of the body part for comfort and easy removal.

Detailed elastic wrap application techniques are presented in individual chapters.

DETAILS

Use elastic wraps of 2 inch width by 5 yard length on the foot, toes, wrist, hand, and fingers; 3 inch width by 5 yard length on the foot, ankle, wrist, and hand; 4 inch width by 5 yard length on the foot, ankle, lower leg, upper arm, elbow, forearm, and wrist; 6 inch width by 5 yard length on the lower leg, knee, thigh, shoulder, upper arm, elbow, and chest/abdomen; 4 inch width by 10 yard length on the knee, thigh, hip/pelvis, shoulder, chest/abdomen, and spine; and 6 inch width by 10 yard length on the knee, hip/pelvis, shoulder, chest/abdomen, and spine.

Migration, slippage, or bunching of the elastic wrap may lessen the effectiveness of the technique (Fig. 1–7). To prevent this from occurring, use one of several methods.

- Apply adherent tape spray to the area prior to applying the wrap.
- Placing non-elastic or elastic tape strip(s) directly on the skin under the wrap is also possible.
  - Tear a 6–8 inch piece of tape and double the strip onto itself, leaving the adhesive mass exposed on both sides.

Fig. 1–7

- Place the strip(s) in a **longitudinal** position directly on the skin and then apply the wrap (see Fig. 1–7A).
- Adjusting anchors may also lessen migration, slippage, and bunching. Begin the wrapping technique by placing the loose end of the wrap on the skin.
  - When applying the first wrap or turn around the body part, fold the loose end over by ⅓–½ of the wrap's width (see Fig. 1–7B).
  - When applying the next wrap or turn, cover the folded end and continue with the technique (see Fig. 1–7C).
- Another method involves placing an elastic tape anchor directly on the skin.
  - When the wrapping technique is completed, apply the anchor partially on the wrap and partially on the skin in an overlapping manner (see Fig. 1–7D).

To fit different areas of the body, cut different lengths of elastic sleeves from a roll. Apply the elastic sleeve directly to the skin by simply pulling the sleeve onto the extremity (see Fig. 6–16). Use the sleeves during athletic, work, and casual activities.

. . . IF/THEN . . .

IF an elastic wrap loses its stretch characteristics and fails to conform to body contours, which is common with repeated use and cleaning, **THEN** use the elastic wrap only during treatment to anchor an ice bag to a body part.

Application of Self-Adherent Wraps

Self-adherent wrap is manufactured on a roll and is applied with the same technique as elastic tape. The

wrap has similar uses as elastic tape and wraps. In many taping techniques, the wrap may be used in place of pre-wrap to provide protection from irritation and additional support to a joint.

- Apply the wrap with firm and consistent tension, following body contours.
- Anchoring does not require fasteners, clips, or additional tape, an advantage of the wrap.
- Avoid gaps, wrinkles, and inconsistent roll tension.

The use of self-adherent wrap is discussed further in individual chapters.

DETAILS

Use self-adherent wrap in 1 inch width by 6 yard length on the toes and fingers; 1½ and 2 inch widths by 6 yard length on the foot, ankle, wrist, and hand; 2¾ and 3 inch widths by 6 yard length on the foot, ankle, lower leg, upper arm, elbow, forearm, and wrist; 4 inch width by 6 yard length on the lower leg, knee, thigh, upper arm, elbow, and forearm; and 6 inch width by 6 yard length on the knee, thigh, hip/pelvis, shoulder, chest/abdomen, and spine.

Application of Cloth Wraps

Use cloth wraps to provide support to the ankle. Apply a cloth wrap over a sock (see Fig. 4–14). Place thin foam pads over high-friction areas under the wrap to reduce irritation. Apply these wraps with firm, constant tension and keep constant pressure on the wrap as it is passed between the hands.

Removal of Wraps

Remove elastic and cloth wraps by unwrapping the material after use. Use taping scissors to cut tape anchors. Remove an elastic sleeve by pulling it off the extremity in a distal direction. Use taping scissors or tape cutters to remove self-adherent wraps. Wash and dry elastic and cloth wraps after each use and reuse.

Clinical Application Question 2

A professor at the local university participating in an intramural basketball league on campus sustains a first-degree **inversion sprain** of the left ankle. He is taken to the athletic training facility for treatment. After applying an ice bag, you decide to use a wrap to provide compression to reduce effusion and swelling.

➠ **Question: What type of wrap can you use?**

. . . IF/THEN . . .

IF small amounts of non-elastic and/or elastic tape, pre-wrap, and/or self-adherent wrap are left on rolls, **THEN** collect the unused rolls in a box; soccer athletes use the tape to anchor shin guards; others use the pre-wrap and self-adherent wrap to tie their hair up; and some use tape and wrap cores to construct heel lifts (see Fig. 6–11) and tear drop thumb spica supports (see Fig. 11–14).

BRACES

Advances in the research and development of bracing techniques provide an opportunity to select among a variety of types. Braces are designed to be used for specific injuries and conditions and are available for the majority of body areas and joints.

Types

Braces can be classified according to their fit, purpose, and body area design (Fig. 1–8).

Fit

The fit of a brace refers to the sizing and manufacturing, either off-the-shelf or custom-made. Off-the-shelf braces come in predetermined sizes, such as small, medium, large, and extra large (see Fig. 1–8A). Off-the-shelf braces are ready to use upon purchase and are generally less expensive than custom-made designs. Although braces are manufactured in predetermined sizes, many companies provide circumference measurements of body areas on the package to assist in proper fitting. Most off-the-shelf braces allow for small size adjustments during wear.

Custom-made braces are fitted and manufactured for specific patients. Manufacturer representatives or orthopedic technicians typically perform the fitting procedures prior to construction of the braces (see Fig. 1–8B). The type of injury, surgical procedure, and rehabilitation, as well as the limb girth, height, weight, and sport/occupation of the patient, often determine which model of brace to purchase. Because the braces are custom-fitted, increases in muscular girth from the development of strength or length of bones from growth periods may need to be considered.

Purpose

Braces are used for dynamic purposes and can be grouped as prophylactic, functional, and rehabilitative.[8] A prophylactic brace is designed to protect an uninjured joint and the surrounding soft tissue structures.

Fig. 1–8 **A** *(Left) Variety of off-the-shelf lower extremity braces. (Right) Variety of off-the-shelf upper extremity braces.* **B** *Custom-made braces. (Left) Elbow. (Right) Knee.* **C** *Variety of prophylactic ankle braces.* **D** *Rehabilitative elbow brace.* **E** *Variety of functional ACL knee braces.*

Use ankle braces, for example, as alternatives to ankle taping to protect against abnormal ranges of motion[9] (see Fig. 1–8C).

A rehabilitative brace is used to provide immobilization following a surgical procedure. Many designs allow for control of range of motion for the patient through the use of adjustable hinges. An example is the use of hinged elbow braces for the progression of passive and active **flexion** and **extension** during rehabilitation following **ulnar collateral ligament** reconstruction (see Fig. 1–8D).

Functional braces are used to provide support and protection for existing injuries or postsurgical repairs or reconstructions.[8] Use off-the-shelf and custom-made brace designs, for example, to reduce anterior translation of the tibia on the femur to protect an injured **anterior cruciate ligament (ACL)** or ACL graft following reconstruction[10] (see Fig. 1–8E).

Body Area

Braces are designed to provide compression, protection, support, and limitations in range of motion for specific areas of the body. For example:

- Orthotics are used for many foot injuries and conditions.
- Braces commonly referred to as walking boots provide immobilization and control of range of motion for foot and ankle fractures and sprains.
- Night splints are used as nocturnal braces to assist in the treatment of plantar fasciitis by keeping the foot in dorsiflexion.
- Prophylactic, functional, and rehabilitative braces for the ankle in lace-up, semirigid, air/gel bladder, and wrap designs provide support and limit range of motion.
- Neoprene sleeves, rubber material commonly coated with elastic nylon, provide compression and support of muscular strains for the lower leg.
- Braces for the knee are available in prophylactic, functional, and rehabilitative designs.
- Neoprene sleeves and shorts support muscular strains of the thigh and hip/pelvis.
- Functional braces worn on the body or attached to football shoulder pads can reduce range of motion with glenohumeral instabilities and rotator cuff pathologies.
- Functional braces are used to lessen medial and lateral stresses and range of motion with ligamentous injuries in the elbow. Rehabilitative elbow braces are used for postsurgical conditions.
- Wrist braces made of neoprene or semirigid materials are available in prophylactic, functional, and rehabilitative designs.
- Braces for the hand and fingers can provide immobilization, support, and compression.
- Functional and rehabilitative braces for the chest/abdomen and spine can provide support and immobilization for a variety of injuries and conditions.

Illustrations and further discussions of these and other braces are found in subsequent chapters.

Braces are constructed from a variety of materials. The materials used vary as much as the types of braces. Many braces are constructed from tempered and aircraft aluminums and carbon composites. Other braces use semirigid plastic, layered nylon, polyester Lycra, and air and gel bladders. Neoprene, porous nylon, and polyester materials are also used in many brace designs.

Objectives of Bracing

Use bracing techniques to:

- Provide support and protection when preventing injuries
- Provide support and protection when treating and rehabilitating existing injuries
- Provide compression to reduce effusion and swelling when treating and rehabilitating injuries
- Provide control of range of motion when treating and rehabilitating injuries

Recommendations for Brace Application

Braces are designed to provide compression, support, and protection for the patient during sport, work, and casual activities. The following recommendations will assist in achieving these objectives. Keep in mind that new braces are similar to footwear in that a few days of wear are required for a break-in period.

Preparation of the Patient

Clean and dry the skin of the patient for brace application. The position of the patient is determined by the type of brace worn. For example, place the patient in a seated position to apply an ankle brace and in a standing position to apply a shoulder brace.

Application of Braces

When purchased, each brace will have specific instructions for application. For proper application and fit, follow the step-by-step procedure carefully. Deviation from the steps may cause injury to the patient. One advantage of bracing techniques is that it is possible to teach the patient the application procedure, which will lessen the time required for health care professionals to assist. Several brace designs allow for adjustments in the outer shell or frame, straps, inner pads, and hinges to achieve proper fit. Follow manufacturer guidelines when performing any adjustments to the brace.

Brace migration is a common problem that may occur even with proper fit. The easiest method to correct migration is to stop the activity and reapply the brace in the step-by-step procedure. Using a neoprene sleeve under the brace can also help lessen migration. However, the additional girth of the sleeve may affect the original fitting measurements of the brace. Applying adherent tape spray over the body area that makes contact with the brace can also lessen migration. If adherent tape spray is used, monitor brace straps for damage from the adherent and chemical components in the spray. This disadvantage of bracing (migration) is also one of its advantages; bracing allows for adjustability and reuse.

Intercollegiate and high school athletic associations provide rules governing the use of braces in practices and competitions. The National Collegiate Athletic Association (NCAA)[11] and the National Federation of State High School Associations (NFHS)[12] allow braces to be

worn if no metal or **nonpliable** substance is exposed. If a metal or nonpliable substance is exposed, closed-cell, slow-recovery foam or similar material of at least ½ inch thickness must cover the areas. Padded covers for many braces may be purchased through the manufacturer. For a more comprehensive discussion of NCAA and NFHS rules, see Chapter 13.

Removal of Braces

The majority of braces can be removed by the patient after use. Release the straps and lift the brace from the body part. Several braces, such as shoulder instability designs and designs attached directly to the skin with tape, do require assistance.

Care of Braces

Clean braces and allow them to dry in a well-ventilated area between use. Clean and inspect braces regularly. Rinse the frames and hinges of rigid braces with clean, fresh water, then drain and air-dry them. Hinge lubrication is typically not required. If lubrication is needed, use a dry lubricant such as Teflon spray. Hand wash straps and frame liners in cold water with mild detergent, then rinse and air-dry. Wash neoprene and other soft brace materials in cold water with mild detergent, rinse, and air-dry. Do not heat straps, liners, or neoprene materials in a dryer. Monitor hinge screws and movable parts for loosening and excessive wear. Replacement straps and frame liners are available for many brace designs.

Clinical Application Question 3

A metal fabricator returns to work following surgery and rehabilitation of the right knee. The surgeon has placed her in a custom-made functional knee brace for all work activities. During the past week in the afternoons, the brace gradually migrates distally.

➠ **Question: What can you do to prevent the migration?**

. . . IF/THEN . . .

IF a brace is no longer needed by a patient to provide protection, support, and/or immobilization, **THEN** wash and retain the brace for use in the future or use for spare parts as recommended by the manufacturer.

PADS

Pads are used to provide protection from injury or further injury for the patient. Many sports require padding during play. Padding techniques range from a simple piece of felt or foam to advanced protective gear such as a football helmet.

Types

Pads are categorized into two basic types: pads made of soft, low-density materials and those of hard, high-density materials[8] (Fig. 1–9). Soft, low-density materials are light and comfortable on the body because of the presence of air in the material. These materials protect the patient from impact forces only at low-intensity levels. By contrast, hard, high-density materials are less comfortable on the body but protect the patient from forces at high-impact levels. These materials have the

Fig. 1–9 **A** *Variety of soft, low-density pads.* **B** *Variety of hard, high-density pads.* **C** *Variety of pre-cut and pre-formed pads.*

ability to absorb energy through deformation, resulting in less force at the area of impact.

Soft, Low-Density Pads

Soft, low-density materials used by health care professionals include cotton, gauze, moleskin, felt, foam, and viscoelastic polymers. These materials come in a variety of lengths, widths, and thicknesses (see Fig. 1–9A). Cotton is found in most facilities and is used to provide a mild padding effect.[7] Apply gauze in various thicknesses to lessen friction or impact forces. Use adhesive gauze material in 2, 4, and 6 inch widths and 2 and 10 yard lengths to lessen friction, cover wound dressings, and attach pads to the body. Moleskin is available in heavyweight and lightweight elastic and non-elastic designs in 1, 1½, 2, 3, 7, 9, and 12 inch widths by 1, 4, 5, and 25 yard lengths. Use the material on high-friction areas to lessen the chance of skin irritations. Moleskin may also be used with many taping techniques to provide additional support. Made from matted wool and rayon fibers, felt comes in thicknesses of 1/16, ⅛, ¼, and ½ inch sheets and 36–108 inch rolls. Many types are available, with and without an adhesive backing, to provide support, protection, and compression. Felt has absorbent properties that allow the material to remain in place during activity.

Foam is available in thicknesses of ⅛, ¼, ⅜, ½, ⅝, ¾, and 1 inch sheets and 36–108 inch rolls, with and without an adhesive backing. Foam is perhaps the most widely used material for padding. Foam material that allows air to transfer from cell to cell is referred to as **open-cell foam**. These foams deform or compress quickly as stress is applied, providing minimal shock-absorbing qualities.[8] Open-cell foam is commonly used as a liner in the construction of custom-made pads. **Closed-cell foam** does not allow transfer of air from cell to cell. These foams are not as comfortable on the body, but the material regains its original shape quickly following impact. Closed-cell foams provide less cushioning at low levels of impact than at high levels of impact.[8] Manufacturers combine both open- and closed-cell foams in the construction of various pads. These padding techniques will be discussed in Chapter 13.

Thermomoldable foams are materials that allow custom-fitting to the patient for protection. The material is available in sheets of 3/16, ¼, ⅜, ½, and ⅝ inch thicknesses. Heat the material first in a conventional oven and then fit to a body part. After cooling, the material retains its shape and can be reheated and remolded if necessary. These foams can be used anywhere on the body, especially as outer padding of rigid casts.

Viscoelastic polymers, used in the design of inner soles, protect against pressure and friction forces. Some of these insoles have an adhesive backing to reduce migration during activity. Use viscoelastic polymers to prevent and treat a variety of injuries and conditions.

Hard, High-Density Pads

Hard, high-density pads are constructed from polycarbonate, plastic, thermoplastic, and casting materials (see Fig. 1–9B). Polycarbonate materials are used in many helmet designs for construction of the outer shell. Off-the-shelf padding designs, such as shoulder pads, use high-density plastics for the outer shell. All of these materials are available in off-the-shelf designs or can be used for custom-made padding techniques.

For custom-made pads, purchase thermoplastic materials made from plastic or rubber with varying amounts of conformability and resistance in thicknesses of 1/16, 3/32, ⅛, and 3/16 inch sheets. Heat these materials at temperatures ranging from 150° to 170°F for 35 seconds to 1 minute for the materials to become pliable for molding to the body part. Use heating sources such as water, a conventional or microwave oven, or a heat gun. The most commonly used source of heat is a hydrocollator. Professionals have between 1 and 5 minutes to mold and shape the material before the thermoplastic cools and becomes rigid. The materials used in the manufacturing process and the material's thickness will affect heating and molding times. Use thermoplastics to protect, support, and splint multiple areas of the body.

Casting materials made from fiberglass or plaster can also be used to protect, support, and splint various areas of the body. Fiberglass material is preferred over plaster by most health care professionals because of the ease of use and less clean-up time required.

Many soft, low-density and hard, high-density pads come in off-the-shelf designs. Moleskin, felt, foam, viscoelastic polymers, and thermoplastic materials are available in pre-cut and pre-formed designs (see Fig. 1–9C). For example, moleskin plantar fascia and turf toe straps, felt heel lifts and arch pads, foam blister and corn pads, viscoelastic polymer orthotics, and thermoplastic thumb spica and wrist cock-up splints are available from manufacturers in a variety of sizes and thicknesses. These pre-cut and pre-formed materials can lessen application and fabrication time and perhaps eliminate wasted materials.

Resilience

The resilience of soft and hard materials will determine their ability to withstand impact forces.[8] Following

impact, highly resilient materials regain their shape. Use these materials over body areas that receive frequent impact. Slow-recovery, nonresilient materials provide optimal protection and are usable over body areas that receive sporadic impact.

Objectives of Padding

Use padding techniques to:

- Provide support and protection when preventing injuries
- Provide support and protection when treating and rehabilitating existing injuries
- Provide compression to reduce effusion and swelling when treating and rehabilitating injuries

Recommendations for Pad Application

The following recommendations will assist in applying padding techniques.

Preparation of the Patient

Because most padding techniques require tapes and/or wraps to secure pads to the body, preparation of the patient should follow the guidelines for taping and wrapping applications.

Application of Pads

Off-the-shelf and custom-made pads may be attached to the body with a variety of methods. The three techniques discussed briefly here are covered in more detail in later chapters. When tape is used, pads are placed over pre-wrap or self-adherent wrap. Elastic tape is used to anchor the pad to the body part in a circular or spiral pattern (see Fig. 9–12). Non-elastic tape may be applied loosely around the pad as an anchor. Elastic wraps are also used to apply pads (see Fig. 8–14). The size of the pad and body part involved will determine the width and length of the wrap. Elastic tape is used to anchor the wrap. With some techniques, apply pads directly to the skin (see Fig. 8–10). The use of adherent tape spray and heavyweight elastic tape lessens migration or slippage of the pad during activity. Exercise care with applying tape directly to the skin daily as allergic reactions and trauma to the skin can occur.

Custom-Made Pads

Custom-made pad designs may be constructed for a variety of body areas. Begin the designs with a paper pattern to avoid wasting materials (Fig. 1–10).

Some manufacturers include paper patterns with the materials to assist with construction. Pads may also be designed by outlining the body part directly on the material, then cutting the material with taping scissors. For example, position a patient on a piece of felt or foam to outline the foot.

Construction of a custom-made thermoplastic pad requires several types of materials and equipment (Fig. 1–11). Select the appropriate thermoplastic material based on conformability, resistance, and thickness. Use soft, low-density foam to line the inside of the pad. Additional equipment includes taping scissors, a heating source, 1 inch or 1½ inch non-elastic tape, 2 inch or 3 inch elastic tape, an elastic wrap, ¼ inch or ½ inch felt, and rubber cement.

. . . IF/THEN . . .

IF mistakes are made in the design and/or construction of custom-made, thermoplastic material pads, causing an irregular fit, **THEN** save the materials in order to use them again, potentially in the design of another pad.

Mandatory Padding

The NCAA[11] and NFHS[12] have rules that govern the use of mandatory injury prevention and injury protection padding for practices and competitions. Sports that require the use of mandatory protective equipment include baseball, fencing, field hockey, football, ice hockey, lacrosse, rifle, soccer, skiing, softball, track and field (padding on pole vault box), water polo, and wrestling. Currently, basketball, gymnastics, swimming and diving, and volleyball do not have rules regarding mandatory protective equipment. Chapter 13 provides a more in-depth examination of protective equipment.

Rules[11,12] governing protective pads prohibit the use of fiberglass, plaster, metal, or other nonpliable materials unless they are covered by closed-cell, slow-recovery foam or similar material of at least ½ inch thickness. Moreover, these hard, unyielding materials may be used to protect an existing injury only. Written verification from a physician may be required. Protective pads cannot create a hazard for the athlete or his or her opponent. The on-site referee or official has the authority to judge whether the protective pad is allowed for use in competition. Seek out the referee or official prior to the start of the competition to obtain approval of the pad. That way, if the pad is found unacceptable, there is time available to make the necessary changes before the competition.

STEP 1: Cover the area to be padded with paper (see Fig. 1–10A).

Fig. 1–10 A

STEP 2: Draw, cut, and shape the pattern based on the objectives of the technique (see Fig. 1–10B).

Fig. 1–10 B

STEP 3: Lay the paper on the padding material and outline the pattern with a felt tip pen (see Fig. 1–10C).

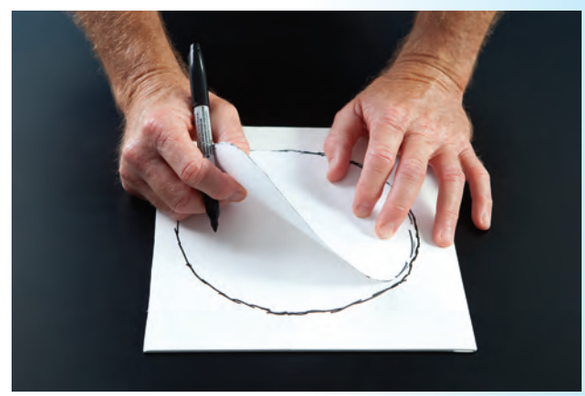

Fig. 1–10 C

STEP 1: Cut a piece of ¼ inch or ½ inch felt slightly larger than the injured area (see Fig. 1–11A).

Fig. 1–11 A

STEP 2: Attach the felt directly to the skin over the injured area with a strip of non-elastic tape (see Fig. 1–11B).

If no paper pattern is available, construct the design of the pad. Using the paper pattern, cut a piece of thermoplastic material. With partial heating of the material, cutting is made easier. Heat the material following the manufacturer's instructions. If using water as the heating source, remove the material when heated and place it on a towel to remove excess water.

Fig. 1–11 B

STEP 3: Apply the pliable thermoplastic material to the body part over the felt pad and lightly mold the material around the contours and felt pad with the hands (see Fig. 1–11C).

Fig. 1–11 C

Steps Cont.

STEP 4: Apply an elastic wrap in a circular or spiral pattern over the body part and thermoplastic material to assist with molding (see Fig. 1–11D).

Fig. 1–11 D

STEP 5: Continue to mold the material to the body with the hands (see Fig. 1–11E).

Pay attention to the recommended amount of time available before the material cools. Apply an ice bag or pack over the material to decrease the cooling time.

Fig. 1–11 E

STEP 6: After the material cools, carefully remove the elastic wrap. Inspect the thermoplastic material to ensure proper shape and contour before removing. Use a felt tip pen to mark on the material any areas that require trimming (see Fig. 1–11F).

Fig. 1–11 F

STEP 7: Remove the thermoplastic material and felt from the body part. Trim the material with taping scissors to remove sharp edges (see Fig. 1–11G). Place the material once again on the body part to make certain of the fit. Additional trimming may be necessary.

Fig. 1–11 G

STEP 8: Completely dry the inside surface of the thermoplastic material. Place the thermoplastic material on soft, low-density foam and outline an area ½ inch larger than the material (see Fig. 1–11H). Cut the piece of foam.

Fig. 1–11 H

STEP 9: If using adhesive foam, remove the backing and attach the foam to the inside surface of the thermoplastic material. Otherwise, apply rubber cement or another non-toxic cement on the inside surface of the thermoplastic material and on the foam side that will be in contact with the material. When the cement is ready, attach the foam to the inside surface of the material (see Fig. 1–11I). The foam should extend ½ inch from each side of the thermoplastic material. This extra padding prevents irritation and possible injury from the semirigid thermoplastic material.

Fig. 1–11 I

Steps Cont.

STEP 10: Use taping scissors to cut the foam away from the raised area shaped by the felt pad (see Fig. 1–11J). This raised area will disperse the impact force away from the injured area to the outer edges of the pad, preventing further damage.

Fig. 1–11 J

STEP 11: Cut strips of elastic tape to line the edges of the pad. Place strips on the top edges of the pad in a square pattern, then on the bottom edges (see Fig. 1–11K).

Fig. 1–11 K

STEP 12: The tape strips should be applied on the thermoplastic material and extend beyond the foam by at least ¼ inch (see Fig. 1–11L). Use the fingers to adhere the top and bottom tape strips together.

Fig. 1–11 L

STEP 13: Trim the edges of the tape around the pad to provide a uniform edge, leaving enough of the tape to maintain adherence (see Fig. 1–11M). The elastic tape prevents separation of the foam from the thermoplastic material following repeated use.

Fig. 1–11 M

Removal of Pads

The removal of mandatory protective equipment is typically done by the athlete following use, although custom-made pads secured to the body part with tape or an elastic wrap may require assistance for removal. Use taping scissors or tape cutters to cut pads secured with tape. Unwrap elastic wraps and reuse them. Remove pads applied directly to the skin with tape as described earlier. Moleskin adheres to the skin more tightly than other materials, especially when used on weight-bearing surfaces of the body. Use particular caution when removing moleskin from the plantar surfaces of the feet. Remove moleskin in the same manner as tape. Using a tape removal solvent may prove helpful.

Clinical Application Question 4

The starting right offensive tackle on your football team has a second-degree **ulnar collateral ligament** sprain of the left thumb. Your team physician will allow him to return to play if the player is placed in a semirigid thumb spica cast.

➠ **Question: What should you do to meet NCAA and NFHS rules?**

STICKING POINTS

This information focuses on "what not to do" or "things to watch out for" when applying taping, wrapping, bracing, and padding techniques. Use these pointers to avoid common mistakes.

Tapes

- Always overlap tape by ½ of the width to avoid gaps and inconsistent layering.
  - Gaps between strips of tape can pinch the underlying skin and result in a blister or laceration. These wounds are referred to as tape cuts.
  - Inconsistent layering can allow the underlying skin to bulge through the tape and cause a blister or laceration. Generally, the application of at least two layers of tape is sufficient.
- Avoid wrinkles in the layer of tape that is applied next to the skin.
  - Wrinkles in the tape can increase the amount of tension over a small area of the skin and result in a blister or laceration.
- When applying tape, focus attention on the correct angles of application.
  - Application angles must follow the contours of the body to prevent constriction of soft tissue or abnormal restriction of range of motion.
- Continually monitor roll tension during application. Students often ask, "How tight does the tape need to be?" The finished technique should fit snugly to the body part and be comfortable to the patient given the objectives of the technique. For example, while the correct application of the elbow **hyperextension** taping technique will limit elbow extension, the elastic tape anchor placed around the proximal upper arm may cause mild constriction of the biceps.

Wraps

- Similar to tape, overlap wraps to avoid gaps and inconsistent layering.
- Gaps or inconsistent layering can affect the mechanical pressure over the injured area. As a result, swelling or effusion can accumulate in these areas, lessening the effectiveness of the technique.

Braces

- Closely follow the manufacturer's instructions when applying braces.
  - The omission or reversal of just one step in the application process may alter the intended purpose or fit of the brace. For example, improperly applying a functional knee brace may allow range of motion beyond the limits of the healing process, possibly predisposing the patient to further injury.
- Use caution when making adjustments or alterations to braces.
  - Cutting or repositioning straps, applying tape anchors, or trimming the brace shell may affect the structural design of the brace. Consult the brace manufacturer if questions arise.

Pads

- Use appropriate materials in the design and construction of protective pads. Select the materials based on the density, resiliency, and thickness.
  - Padding of the **acromioclavicular (AC) joint** following a sprain or **contusion** requires several types of materials. Construct the outer shell from hard, high-density thermoplastic material and line the inside of the pad with low-density foam. Using only low-density foam will not provide effective protection from high-impact forces.

EVIDENCE-BASED PRACTICE

As discussed in the chapter, evidence-based practice (EBP) is a five step process undertaken to incorporate the best evidence; expertise of the clinician; and patient goals, values, and preferences into clinical decisions for patients. Understanding and practicing with the steps is necessary to effectively implement your findings into clinical practice. Use this activity with your faculty and clinical preceptor to develop the knowledge and skills of EBP. At the conclusion of later chapters, "Evidence-Based Practice" activities will present a clinical case and provide the opportunity to further develop your skills in the EBP process.

The steps of EBP are (1) developing clinically relevant questions, (2) searching for the best evidence, (3) evaluating and appraising the evidence, (4) implementing the evidence into clinical practice with patients, and (5) evaluating the effects of interventions on patient outcomes.

Clinical Question

The first step in the EBP process is developing a relevant clinical question in the PICO format to answer. At the clinical site, closely observe the taping, wrapping, bracing, and padding techniques used and applied to the athlete and patient population. Ask yourself questions such as "Which technique is the most effective to prevent inversion ankle sprains?" "Are neoprene knee sleeves beneficial for meniscal tears?" "What is the best way to protect an AC joint sprain?" or "How can I provide support to the MCP joint of an athlete with allergies to adhesive tape and neoprene?" Develop three to five clinically relevant questions in the PICO format using these examples or specific situations or questions at the clinical site. The questions must include the patient population or problem, the intervention, a comparison intervention (if relevant), and the clinical outcome of interest. For example, "Do lateral strap braces reduce pain in racquetball players with chronic lateral epicondylitis?" Seek assistance from your faculty and clinical preceptor in the development of the questions.

Searching for Evidence

Find the answer to the clinically relevant question by searching for the best available evidence. Choose one of the clinical questions formulated at the clinical site and develop a search strategy with assistance of your faculty and/or library staff. Based on the clinical question, the strategy should include search terms, search limitations, and electronic databases and online and print journals to search. Using the clinical question example, "Do lateral strap braces reduce pain in racquetball players with chronic lateral epicondylitis?," search terms could include lateral epicondylitis, elbow strap braces, and pain reduction. Search limitations could include randomized controlled trials, age restrictions in study participants to match your patient population, and studies published in the last 3 to 5 years. Databases and journals are those most relevant and accessible to retrieve quality evidence to answer the clinical question. Use

the strategy and perform the search. The results of the search can be varied, producing numerous or limited findings. And remember, evidence from expert opinion or clinical experience occasionally guides clinical decisions. Develop a list of retrieved citations, abstracts, and articles and thoroughly review each to determine those most relevant to the clinical question. After this review, obtain full text articles of the studies and reviews selected.

Evaluating the Evidence

A critical appraisal is needed to determine the value of the evidence to clinical practice. Choose three studies from the search and evaluate each with these questions, "Are the results of the study valid?" For example, Were the patients randomized? Was the study blinded? Was there a complete follow-up? "What are the actual results?" For example, What was the treatment effect? Were the results similar across studies? What is the clinical and/or statistical significance of the results? "Are the findings clinically relevant to my patients?" For example, Were the study participants similar to my patient population? Is the intervention cost-effective? Will my patients benefit from the intervention? Seek assistance from your faculty as this step requires the most judgment and experience in the EBP process. Prepare a summary of the answers to the questions for each study. Synthesize the study findings and appraisal to determine the implications for clinical practice.

Implementing the Evidence

Following the appraisal, you must determine whether and how the evidence is implemented into the clinical situation. Involve your faculty and clinical preceptor and critically examine and integrate the available evidence, your clinical experience, and the patient goals, values, and preferences to determine the clinical course of action at the clinical site. For example, a new taping, wrapping, bracing, or padding technique is supported by evidence, but the subjects in the studies do not match your patient population for age and physical conditioning; as a result, the new technique is not implemented and other interventions are considered. In another clinical situation, a taping, wrapping, bracing, or padding technique not previously studied continues to be used with patients based on the past experiences of the clinician and successful patient outcomes.

Evaluating the Outcomes

The last step in the EBP process is evaluating the effects of interventions on patient outcomes. For example, how well did the EBP process work? Was the clinical question answered? Did the search produce quality evidence and was the evidence critically appraised? Did the integration of the available evidence, clinician expertise, and patient goals and preferences produce a rational clinical decision? Did the clinical decision result in successful outcomes for the patient(s)? What was your experience with the EBP process? Use these questions and develop others specific to the patient(s) in the clinical site. Develop answers to each question, evaluating your performance and the clinical outcomes. Involve your faculty and clinical preceptor in a discussion of the answers and how EBP can enhance your skills for improved patient care.

WRAP-UP

- The best available evidence, clinician expertise, and patient goals and values should guide clinical decisions for patient care.
- Apply non-elastic, elastic, and cast tapes to support and reduce range of motion, and secure wraps, pads, and dressings.
- Tapes are torn manually or cut with taping scissors.
- Tapes are commonly applied directly to the skin or over pre-wrap, self-adherent wrap, or cast padding.
- Remove tape from the body manually or with taping scissors or cutting tools.
- Use wraps to provide compression and support, reduce range of motion, and secure pads and dressings.
- Several methods may be used to prevent migration, slippage, or bunching of wraps.
- Wraps are rolled onto the body and removed by unwrapping or cutting.
- Off-the-shelf and custom-made braces provide support, protection, and compression, and control range of motion.
- Follow the manufacturer's step-by-step procedures when applying braces.
- Soft, low-density and hard, high-density padding materials provide support, protection, and compression.
- Pads may be applied to the body in a variety of methods.
- NCAA and NFHS rules mandate padding of all exposed nonpliable materials for practices and competitions.

- Before applying tapes, wraps, braces, and pads, clean and dry the skin of the patient, then position the body part according to the technique objective.
- Overlap tapes and wraps and avoid gaps, wrinkles, and inconsistent roll tension during application.

WEB REFERENCES

Active Ankle Systems
http://www.activeankle.com
- This website is an online catalog for the brace manufacturer and provides injury prevention and care, fitting, and ordering information.

Andover
https://andoverhealthcare.com/sports-medicine-products/
- This site provides information about a variety of tapes and self-adherent wraps, presentations, and demonstrations, as well as resources for college professors and students.

Breg
http://www.breg.com
- This website is an online catalog for the manufacturer and provides sizing information on prophylactic, rehabilitative, and functional braces.

BSN Medical
http://www.bsnmedical.com/
- This site allows you access to information on tapes, wraps, braces, pads, and wound care products.

DJO
http://www.djoglobal.com/
- This site is an online catalog for the manufacturer and provides research and development and fitting information about prophylactic, rehabilitative, and functional braces, and pads.

Hartmann
https://hartmann.info/en-US
- This website is an online catalog for the manufacturer and provides information about a variety of tapes, wraps, braces, pads, and wound care products.

Henry Schein
https://www.henryschein.com/us-en/medical/default.aspx?did=medical&stay=1
- This site is an online catalog for sports medicine products, including tapes, wraps, braces, and pads.

Johnson & Johnson
http://www.jnj.com/
- This site provides access to information on tapes, wraps, pads, and wound care products and educational resources for patients and students.

Medco
http://www.medco-athletics.com/
- This website is an online catalog for sports medicine products, including tapes, wraps, braces, and pads.

MedSpec
http://www.medspec.com
- This site is an online catalog for the brace manufacturer and provides fitting and ordering information.

Sports Health
http://www.sportshealth.com/
- This website is an online catalog for sports medicine products and provides fitting and ordering information and educational materials and resources.

3M
http://www.3m.com
- This site provides access to information on tapes, wraps, pads, and wound care products and educational materials and resources.

Ultra Ankle
http://www.ultraankle.com
- This website is an online catalog for the brace manufacturer and provides fitting and ordering information.

FURTHER READING

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their quality? Arch Pediatr Adolesc Med 152:812–817, 1998.

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