Hurley, J Sam

From: Jonnathan Busko <jbuskomd@yahoo.com>
Sent: Monday, September 25, 2023 2:29 PM
To: Brent J. Libby; Matthew Sholl; Hurley, J Sam; Zimmek1
Subject: Critical Access Practitioner Extender
Attachments: CAPE Formulary 1.0.docx; CAPE Scope of Practice 1.0.docx; CAPE _ Concept Rules v 1.0.docx; CAPE Clinical Care Guidelines v 1.0.docx; International Wound Journal - 2022 - Luo.pdf

Dear Chair Libby, Dr. Sholl, Director Hurley, and Dr. Zimmerman,

As requested, please find attached the first draft of the materials to transition the Critical Access Physician Extender Pilot Project to a regular service line offering for Maine EMS as Critical Access Practitioner Extender. Included are proposed rules, clinical care guidelines, the formulary, and the scope of practice document. Once the final scope of practice is completed, I will send updated education and credentialing documents that can be used by the education committee to establish standards.

Additionally, based on our experience and the demonstrated efficacy of the program, some changes to the scope of practice are proposed. Many of these come from the effectiveness of the telemedicine process in allowing real-time oversight of the CAPEs. Here is a summary of changes made from the Pilot Project to this proposal.

- Emergency (911 EMS) procedures are removed. This includes TNK (and ancillary meds) for STEMI and POCUS IV. Once the Pilot project is terminated, if TNK/ancillary meds for STEMI has not been approved in the 911 MEMS protocols, NEMHS will reapply for a pilot project specifically to that protocol.
- Eligible primary license levels have been expanded to include both AEMT and Paramedic. This is based on the assessment by pilot participants that the CAPE scope of practice does not specifically build on the paramedic scope of practice but rather enlarges it and that the AEMT comes in with a sufficient primary license scope of practice to effectively perform the CAPE role with the same CAPE training a paramedic would receive.
- Added running sutures. This was previously discussed but now there is a nice meta-analysis (attached) that reviews all the prior studies that demonstrates equivalent or superior outcomes with running sutures versus interrupted sutures vis-a-vis cosmesis, functional outcome, and infection.
- Added serving as the local site dispenser for an Automated Pharmacy System as defined by the Board Of Pharmacy's rules under Chapter 20. As you are probably aware, rural pharmacy access has also become a challenge in Maine (https://www.newscentermaine.com/article/news/health/towns-in-rural-maine-struggle-with-a-lack-of-pharmacies-health-care/97-e5d1ec75-fa0a-427f-98bd-a594386f8386). The Board of Pharmacy discussed this during the last legislative session and is working within Chapter 20 to come up with ways to safely increase communities' access to retail pharmacy services through staffed Automated Pharmacy Systems (not prescription vending machines). EMS providers are already obliquely permitted under the Pharmacy' Board's rules to serve as the dispenser for such an arrangement as they are "a person legally qualified under a health practice act to administer drugs" but the Pharmacy Board his signaled an intention to specifically list EMS in its rules with its current rule making process. This would allow, through an arrangement with a retail pharmacy, for a CAPE program to not just meet the patient's immediate urgent care needs but also the prescriptions generated through the telemedicine encounter.
- Definition of telemedicine was clarified to be explicitly in alignment with Maine law.
- Added management of minor burns.
- Added management of friction blisters.
- Added ultrasound guided needle aspiration of superficial cutaneous abscess.
- Added use of cotton tip applicator for the removal of lid FBs.
- Added a selection of labs that we've been asked to consider for the urgent care setting.

I am available to discuss this content with the MEMS Board on Wednesday, October 4 and am available to discuss this with the MDPB on Wednesday, October 18. I look forward to working with all of you to make this a permanent part of EMS practice in Maine.

Be well,

Jonnathan

water16 DEPARTMENT OF PUBLIC SAFETY

163 BUREAU OF EMERGENCY MEDICAL SERVICES (MAINE EMS)

CHAPTER XX: Critical Access Practitioner Extension

§1. Definitions

1. ***"Critical Access Practitioner Extension"*** means the facilitation of an Audio and (static or dynamic) Visual telehealth visit performed by a remote site Physician, Physician Assistant, or Nurse Practitioner by an emergency medical services provider functioning as a Critical Access Practitioner Extender, primarily in an out-of-hospital setting to provide episodic patient evaluation, advice, and treatment directed at preventing or improving a particular medical condition, within the scope of practice of the emergency medical services provider as specifically directed by the Physician, Physician Assistant, or Nurse Practitioner performing the telehealth visit.

2. ***"Formulary"*** means a list of substances that may and may not be administered, and the routes available for their administration in the context of Critical Access Practitioner Extension, defined within the *Critical Access Practitioner Extender Formulary document*, and is incorporated by reference.

§2. Critical Access Practitioner Extender Personnel Licensure Level

1. Critical Access Practitioner Extender Personnel Licenses are issued for the following level of care:

A. Critical Access Practitioner Extender

2. Critical Access Practitioner Extender Personnel licensed under this chapter may only provide Critical Access Practitioner Extension care when affiliated with and acting as an agent of an agency licensed as a Critical Access Practitioner Extension agency.

3. To obtain and maintain a new or renewed Critical Access Practitioner Extender license, the applicant must:

B. Be affiliated with a Maine EMS licensed service approved by the Board to provide Critical Access Practitioner Extender Services at the time of initial application.

C. Possess and maintain active, unrestricted Maine EMS licensure at the AEMT or Paramedic level

D. Submit the following to Maine EMS:

a) A completed Maine EMS Critical Access Practitioner Extender application signed by the applicant.

b) For initial licensure, proof of successful completion of Maine EMS-defined Critical Access Practitioner Extender training to include documentation of completion of all required elements for Critical Access Practitioner Extender credentialing, defined within the **** document and is incorporated by reference.

c) In the case of an applicant whose Critical Access Practitioner Extender license is current or not expired by more than one year, Board approved continuing education hours.

(1) The applicant must submit proof of completion of Maine EMS defined Critical Access Practitioner Extender continuing education and mandatory recredentialing (defined within the **** document and is incorporated by reference) provided that:

(a) Certificates of continuing education hours have not been used for a previous license renewal and have been earned within their licensure cycle.

E. Submit a complete history of any action taken against any emergency medical services certification or license or professional certification or license that the applicant currently holds or has ever held.

§3. Scope of Practice

1. The scope of practice for a Critical Access Practitioner Extender is defined within the *Critical Access Practitioner Extender Scope Of Practice document* and is incorporated by reference. Copies of this document are available at Maine EMS.

2. The scope of practice for a Critical Access Practitioner Extender is inclusive of the scope of practice of the individual's primary Maine EMS license.

3. If the Critical Access Practitioner Extender also holds a concurrent Maine EMS Community Paramedicine Affiliate, Technician, or Clinician License, the Critical Access Practitioner Extender scope of practice is inclusive of the Community Paramedicine License and is defined within the CCCC document (Community Paramedicine Affiliate), DDDD document (Community Paramedicine Technician), or EEEE Document (Community Paramedicine Clinician) for the Community Paramedicine License level and is incorporated by reference. Copies of this document are available at Maine EMS.

4. The Critical Access Practitioner Extender shall practice within the Critical Access Practitioner Extender Clinical Care Guidelines defined in FFFF Document and is incorporated by reference.

5. If a formal, contractual arrangement exists between a healthcare facility and the Critical Access Practitioner Extension Licensed EMS Agency in which the Critical Access Practitioner Extender will be directly (in-person) supervised by a Maine licensed qualified healthcare practitioner (MD, DP, PA, or independent NP), then the Critical Access Practitioner Expender will be considered an "employee" of the healthcare facility as it is used in MRS Title 32, §85.7.A and the provisions of MRS Title 32, §85.7 shall apply to the individuals practice in that setting only.

§4. Critical Access Practitioner Extender Formulary

1. The Formulary identifies what medications may or may not be administered following a practitioner order for a Critical Access Practitioner Extender provider. The formulary will act as an expansion of existing protocols. If the Critical Access Practitioner Extender holds a concurrent Community Paramedicine License, the Community Paramedicine Formulary for that Community Paramedicine License is incorporated into the Critical Access Practitioner Extender formulary.

§5. Critical Access Practitioner Extension Service Licensure

1. To obtain a new Critical Access Practitioner Extension service license an emergency medical services provider, including but not limited to an ambulance service or non-transporting emergency medical service, must apply to Maine EMS for approval. In order to obtain this license, the provider must:

A. Apply on forms available from Maine EMS;

B. Provide a description of the intended Critical Access Practitioner Extension Plan to be approved by the Board or Maine EMS staff addressing at minimum:
   - An initial and ongoing (recredentialing) training plan

- A signed MOA / contract with a qualified healthcare practitioner (physician, PA, or NP) or practice group of qualified healthcare practitioners to perform the telehealth visits
- Pharmacy Agreements

C. Have a quality assurance and quality improvement plan that directly addresses Critical Access Practitioner Extension;

D. Demonstrate to Maine EMS that it has designated an emergency medical services medical director; the emergency medical services medical director must co-sign the Critical Access Practitioner Extension Service License Application.

2. Any individual licensed under this chapter who is providing Critical Access Practitioner Extension services, is required to complete a background check through the Maine Background Check Center for their Critical Access Practitioner Extender Personnel and must ensure that their Critical Access Practitioner Extender Personnel maintain enrollment. The results, including all subsequent results received from the Maine Background Check Center, must be electronically reported through an office of Maine EMS approved system, within 48 hours to the Office of Maine EMS.

3. Any licensed service must conduct mandatory reporter training during the onboarding of any Critical Access Practitioner Extender Personnel, and annually, for anyone providing Critical Access Practitioner Extension services or overseeing the program.

4. Patient Records
   a. For each request for service, or for each patient when more than one patient is involved, the individual licensed under this chapter who is primarily responsible for providing Critical Access Practitioner Extension services, must complete and submit an electronic Maine EMS patient care report, as specified by Office of Maine EMS, within twenty-four hours from the time they provided service to the patient.
5. Business records
   a. Business records of the Critical Access Practitioner Extension Licensed Service shall be kept and retained in a manner consistent with all applicable city, state and federal laws, ordinances and regulations with proper audit trails available. Business records, contracts, and newspaper advertisements will be retained for a minimum of five (5) years.
   b. A Critical Access Practitioner Extension Licensed Service must make its records available for inspection at the request of the Maine EMS Office.
   c. Proof of current licensure of all licensed Critical Access Practitioner Extension

personnel employed directly by the agency.

d. The Critical Access Practitioner Extension Licensed service shall keep a personnel file for each Critical Access Practitioner Extender personnel employed which shall include, but not be limited to:
    i. Their application for employment
    ii. Evidence of current qualifications;
    iii. Evidence of orientation and in-service training
    iv. Periodic evaluations.

6. Once an application for a new or renewed Critical Access Practitioner Extension Service license has been accepted as complete by Maine EMS, Maine EMS shall grant, refuse, or conditionally grant the license within 70 days.

7. Any actively licensed Critical Access Practitioner Extension Agency that wishes to change their Critical Access Practitioner Extension Plan approved by the Board or the Office of Maine EMS, must submit a formal request to the Office of Maine EMS

    A) Should the change be deemed significant change in the scope of work the agency may be required to submit a new application.

    B) Should the change be deemed a minor change the agency will just need to submit an addendum for review by the office. Following review and approval the agency can implement said change.

8. All Critical Access Practitioner Extension Licenses will be issued for up to 13 months, with an expiration date of November 30.

This section of rule is effective XXX days after publication of the adopted rule by the Secretary of State's Office.

§8 Critical Access Practitioner Extension Service Licensure Renewal

1. A service applying for renewal of their Critical Access Practitioner Extension Service Licensure must submit current MOA / Contracts for telemedicine services.

§9 Critical Access Practitioner Extension Service Onboarding Requirement

1. A service licensed to provide Critical Access Practitioner Extension services must ensure its employees have received training to the standard within its Critical Access Practitioner Extension Plan prior to those employees providing Critical Access Practitioner Extension services.

AUTHORITY:

EFFECTIVE DATE:

ADOPTED:

REPEALED AND REPLACED:

Critical Access Practitioner Extender (CAPE)
Clinical Care Guidelines

Attention: If a patient is undergoing treat and transport EMS care, do not utilize these Critical Access Practitioner Extender Clinical Care Guidelines. None of the procedures in these CAPE Clinical Care Guidelines may be performed until the following conditions have been met:

1. The patient has undergone a CAPE facilitated telemedicine visit by a qualified healthcare practitioner AND
2. The qualified healthcare practitioner has ordered the performance of the procedure or intervention.

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Foreword

Traditional EMS practice is based on a model of standing orders used on EMS provider discretion with live practitioner intervention (On-Line Medical Control) reserved for select cases. As such, EMS protocols must limit EMS providers to performing only those interventions for which they have both the judgment to make the decision to perform the procedure and the skill to perform the procedure. Maine EMS protocols do not allow EMS clinicians to discharge patient from care. Instead, they must either transport patients or have the patients sign a refusal of medical care / refusal of transport.

The practice of Critical Access Practitioner Extension, on the other hand, recognizes that there are many patients who can be safely discharged from EMS care. Numerous studies have demonstrated that on their own, EMS clinicians do not have the judgement to determine who can be safely discharged from EMS care. Physicians, physician assistants, and nurse practitioners, collectively known as Qualified Healthcare Practitioners (QHP), on the other hand, regularly practice disposition medicine and are qualified to determine which patients can be safely discharged from EMS care.

The intention of Critical Access Practitioner Extension is to allow the EMS provider to safely provide care to patients who do not require emergency department level care and then discharge them from EMS care. This can be accomplished by having EMS providers facilitate telemedicine visits with Qualified Healthcare Practitioners and only perform those interventions ordered by the qualified healthcare practitioner. In this arrangement, the EMS provider has the technical skill to perform the ordered interventions and the qualified healthcare practitioner provides the judgment as to the appropriateness of performing the intervention as well as to the ultimate disposition of the patient.

These Clinical Care Guidelines are designed to supplement, not replace the Maine EMS protocols. The EMS provider has a technical proficiency and scope of practice defined by the Maine EMS protocols and patients who may be safely discharged from care (e.g. urgent care patients) may benefit from both the expanded scope of practice contained in these Clinical Care Guidelines as well as the interventions authorized in the Maine EMS protocols (including, if the CAPE is so licensed, Community Paramedicine interventions). Nonetheless, once the CAPE-licensed EMS provider chooses to provide Critical Access Practitioner Extension care, all interventions must be ordered by the qualified healthcare practitioner in the context of a telemedicine visit.

Note that the method of the request for service does not disqualify a patient from receiving Critical Access Practitioner Extension Services. Each agency and community will establish service delivery models that make the most sense for them. In some cases, a fixed, permanent access point (e.g. EMS / Fire station, community health center, medical office) will be most appropriate, while in others providing Critical Access Practitioner Extension services in the context of 911 response or from temporary locations will be most appropriate. For some agencies, a combination of all of these arrangements will work best. What is required is that regardless of how a patient accesses Critical Access Practitioner Extension services, the agency uses established processes for screening for eligibility and meeting telemedicine visit requirements in the settings in which the care will be delivered.

Restriction of the use of these clinical care guidelines

1. If a patient is being transported to a medical facility for care by a qualified healthcare practitioner and the Critical Access Practitioner Extender does not intend to facilitate a telemedicine visit, these Clinical Care Guidelines may not be used.
2. All patients who are considered potential candidates for Critical Access Practitioner Extension services must undergo CAPE-ESI triage. If, based on CAPE-ESI triage, the patient does not qualify for Critical Access Practitioner Extension services, the call must be treated as a routine EMS call and these Clinical Care Guidelines may not be used.
3. With the exception of performing an expanded physical exam and using telemedicine techniques for capturing store and forward clinical data, a telemedicine patient evaluation by a qualified healthcare practitioner must occur and that qualified healthcare practitioner must order the interventions prior to the Critical Access Practitioner Extender performing the skill (e.g. even if you can see it, until the telemedicine visit is performed and an order given, you cannot remove a foreign body from an ear).
4. If a telemedicine visit (defined at a minimum as a visit with visual store and forward image acquisition and synchronous audio communication between the qualified health healthcare practitioner and the patient, and preferably with synchronous A/V teleconferencing) cannot be performed, the Critical Access Practitioner Extender may not utilize the scope of practice defined in these Clinical Care Guidelines.
5. It may be possible for a Critical Access Practitioner Extender to be fully trained but not fully credentialed by virtue of not completing all the live performance requirements for a given skill or procedure. It is the responsibility of the CAPE to know what skill she/he is credentialed to perform and, if ordered to perform a skill that she/he is not credentialed to perform, to inform the ordering telemedicine practitioner of that information.

General Patient Management Process

The following process should be followed on all patients. Based on the severity of the patient's illness, the timing of the steps should be adjusted to maximize the individual patient's care.

Process

- Identify the patient (name, DOB) if possible.
- If a patient clearly requires treat and transport EMS care, follow the current Maine EMS Protocols
- If there is a possibility that a patient may be eligible for Critical Access Practitioner Extension treat and discharge services, perform a triage intake and determine the patient's triage level.
    - Use CAPE ESI Triage
- Perform a focused history and physical based on the chief complaint.
- If the patient does not qualify for Critical Access Practitioner Extender Care based on the CAPE-ESI triage or the findings of the history and physical exam, initiate care per MEMS protocols.
    - Request mutual aid response if appropriate.
    - Initiate transport if appropriate.
- If the patient is felt to be potentially appropriate for care in place, initiate CAPE-telemedicine process
    - Provide a focused presentation to the telemedicine practitioner.
    - Facilitate the telemedicine practitioner's history and physical exam.
    - Perform telemedicine practitioner orders consistent with the appropriate Clinical Care Guideline and the Critical Access Physician Extender's training and credentialing.
    - Provide / administer medications as ordered.
    - Arrange follow-up as directed and as per local practice.

Local Anesthetic Injection Techniques

Local anesthesia and blocks are indicated for wound management and abscess drainage.

Local anesthetics for this protocol:
1% and 2% lidocaine with or without epinephrine
Non-ethyl chloride wound safe topical anesthetic spray

Procedure

- Perform the anesthesia technique as discussed with the telemedicine practitioner.
    - For all techniques:
        - Warm the anesthetic to body temperature
        - Use the smallest needle possible (25 g or smaller)
        - Inject slowly
        - Wait at least 5 minutes after injection to start procedure
        - Consider using topical anesthetic spray first on intact skin before injection
    - Local infiltration
        - Key points
            - Unless the wound is grossly contaminated, always infiltrate subcutaneously through the wound, not through intact skin
            - Advance the needle “to the hub” and inject while withdrawing
    - Field block (local infiltration not through the wound)
        - Key points
            - Anesthetize circumferentially to the procedure site but the infiltration proximal to the procedure site is most critical
            - As much as possible, do not completely withdraw the needle but rather rotate the tip at the entrance site to extend infiltration
            - If multiple skin punctures are needed, puncture through already anesthetized skin
    - Digital block
        - Key points
            - Aseptic, not sterile technique
    - Topical anesthetic spray
        - Key points
            - Follow manufacturers’ guidelines as to allowable quantity and location of spray

Soft Tissue Injury Management: Primary and Delayed Primary Wound Closure

Many wounds can be successfully closed primarily and even those that are not appropriate for primary closure still benefit from early interventions.

Contraindications

The following wounds are not appropriate for closure by the Critical Access Practitioner Extender

- Wounds of the lip or that cross the vermillion border of the lip
- Wounds to eyelids
- Wounds to the ear
- Wounds to the genitalia
- Nailbed wounds
- Grossly contaminated wounds
- Wounds with suspected retained foreign bodies
- Wounds with underlying muscle, muscle sheath, tendon, or ligament injury
- Wounds associated with large vessel injury or neurologic injury
- Human or animal bites
- High pressure injection injuries
- Face or scalp wounds greater than 24 hours since injury
- Any other wounds greater than 6 hours since injury
- Any wound missing significant soft tissue as determined by the telemedicine practitioner.

Procedure:

- Contact telemedicine practitioner for wound co-evaluation
- Perform the appropriate wound management as discussed with telemedicine practitioner
    - May include anesthesia as directed per "Anesthetics Techniques"
    - May require anesthesia and wound cleaning before a final management decision can be made
- Technique
    - For all wounds
        - All wounds, regardless of whether they will be closed with primary or delayed primary closure or secondary intention, must be appropriately cleaned and prepared
            - To achieve optimal cleaning, wound anesthesia is usually required
            - All wounds must appropriately irrigated
                - Warm tap water for 5 minutes is the preferred method
                - Otherwise, use at least 100 ml of irrigating solution per cm of wound length delivered with a ZeroWet or similar device or 18 g IV catheter
            - Grossly contaminated wounds may be scrubbed with a surgical sponge but these wounds must then be treated with delayed primary closure
            - Visible foreign bodies may be removed with forceps, irrigation, or scrubbing
            - Perform limited debridement as directed by the telemedicine practitioner
            - Discuss the need for antibiotics, rabies prophylaxis, and tetanus immunization with telemedicine practitioner
        - Wound preparation for wounds to be closed
            - Wear a mask
            - Use clean non-sterile gloves or sterile gloves if needed for better fit

        - Disinfect the wound immediately adjacent to the wound with FDA approved cleaning solution
        - Place a fenestrated drape or multiple sterile towels around the wound site
        - Explore the length and depth of the wound
            - If the wound is on an extremity, examine the wound through the full range of motion of the extremity
- Primary wound closure
    - Indications
        - Clean wound
            - Minimal or no contamination
        - Wound margins can be aligned
            - Minimal (superficial) or no debridement required
    - Technique
        - If directed by telemedicine practitioner, perform superficial debridement.
        - Achieve hemostasis
        - For all techniques except tissue adhesive and running sutures, the general technique is to bisect the wound with the closure device and then continue to bisect the remaining sections until wound closure is achieved.
        - Perform closure technique as discussed with telemedicine practitioner
            - Skin tape
                - Dry wound and surrounding skin
                - Apply liquid adhesive around wound (e.g. tincture of benzoin)
                - Cut tape for 2-3 cm overlap on each side of the wound
                - Apply half of strip on one side of the wound, firmly oppose the opposite wound edge to its counterpart, and apply the remainder of the tape on the other side of the wound
                - Repeat as needed, bisecting the wound, until the margins are opposed.
                - Dress with a dry sterile dressing and a bandage
                - Provide patient with appropriate written / electronic discharge instructions.
            - Tissue adhesive (skin glue)
                - Appropriate for single layer closure of wounds without significant tension
                - Dry wound and surrounding skin
                - Appose wound edges
                - Follow manufacturer's instructions for proper application of the product
                - Once dry, apply a dry sterile dressing
                - Counsel the patient to NOT apply antibiotic ointments or petroleum ointments on the wound as these will weaken the adhesive
                - Provide patient with appropriate written / electronic discharge instructions.
            - Wound staples
                - May require deep sutures to reduce superficial tension
                - Appose and evert the wound margins

        - Place staples to bisect the wound and then bisect each section
        - Apply antibiotic ointment
        - Cover with a dry, sterile dressing.
        - Provide patient with appropriate written / electronic discharge instructions.
    - Suturing
        - Telemedicine practitioner will provide guidance on:
            - Suture material(s) to use.
            - Technique to use.
        - Single layer closures are permitted.
        - The following suturing techniques are permitted:
            - Simple interrupted
            - Running sutures
        - Apply antibiotic dressing.
        - Apply a dry sterile dressing.
    - Update tetanus immunization status as indicated.
    - Request telemedicine practitioner evaluation of the wound closure prior to discharge.
    - Provide patient with appropriate written / electronic discharge instructions.
- Delayed primary closure.
    - For wounds not appropriate for primary closure
    - Technique
        - Clean wound meticulously
        - If directed by telemedicine practitioner, perform superficial debridement.
        - Place moist dressings in and over the wound.
        - Bandage the wound.
        - Update tetanus immunization status as indicated.
        - Instruct the patient to contact the primary care provider to arrange follow-up in 4 days for closure or, if no PCP available, to present to an emergency department.
        - Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Removal of a superficially embedded fishhook

Many superficially embedded fishhooks can be easily removed without the patient requiring emergency department care.

Contraindications:

Foreign body embedded in the globe of the eye.
Foreign body embedded in the genitalia.
Non-superficially embedded foreign bodies.

Procedure

- Contact telemedicine practitioner for foreign body co-evaluation.
- Perform anesthesia if directed by telemedicine practitioner as per "Anesthetics Techniques."
- Perform embedded foreign body removal as directed by telemedicine practitioner.
    - Indications
        - Removal of an embedded fishhook
    - Technique
        - Consider screening soft tissue ultrasound if directed.
        - If directed, perform local anesthesia or digital block.
        - Fishhook removal
            - Tape or cut off any exposed, nonembedded barbs.
            - Use one of the four techniques as discussed with telemedicine practitioner.
                - Advance and cut
                - String-yank
                - Needle cover
                - Retrograde
            - Apply antibiotic ointment and adhesive bandage.
            - Inform patient there may be retained foreign body and refer for an x-ray.
            - Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Removal of a superficially embedded splinter

Many superficially embedded splinters can be easily removed without the patient requiring emergency department care. This guideline applies only to splinters 1 mm in diameter or less embedded intradermally.

Contraindications:

Foreign body embedded in the globe of the eye.
Foreign body embedded in the genitalia.
Non-superficially embedded foreign bodies.

Procedure

- Contact telemedicine practitioner for foreign body co-evaluation.
- Perform anesthesia if directed by telemedicine practitioner as per "Anesthetics Techniques."
- Perform embedded foreign body removal as directed by telemedicine practitioner.
    - Indications
        - Removal of a superficially embedded splinter 1 mm in diameter or less
    - Technique
        - Consider screening soft tissue ultrasound if directed.
        - If directed, perform local anesthesia or digital block.
        - Splinter removal
            - Grasp and withdrawal splinter with appropriate instrument(s)
            - Evaluate for retained pieces of the splinter.
            - Apply antibiotic ointment and adhesive bandage.
            - Inform patient there may be retained foreign body and refer for an x-ray as directed.
            - Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Removal of an attached tick

Many attached ticks can be easily removed without the patient requiring emergency department care.

Procedure

- Contact telemedicine practitioner for tick co-evaluation
- Perform attached tick removal as directed by telemedicine practitioner
    - Indications
        - Removal of an attached tick
    - Technique
        - Consider screening soft tissue ultrasound if directed
        - If directed, perform local anesthesia or digital block
        - Attached tick removal
            - Preferred method: Tick spoon or similar
            - Alternate technique: Forceps / instrument grasp
            - Apply antibiotic ointment and adhesive bandage
        - Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Subungual Hematoma Electrocautery Trephination

Although not life threatening, blood under the fingernail can be very painful and impair function.

Procedure

- Contact telemedicine practitioner for foreign body co-evaluation
    - Electrocautery nail trephination for subungual hematoma
        - Indication
            - Subungual hematoma greater than 50% of the nail bed
            - Intact paronychial folds
            - Acute (less than 48 hours) injuries
            - Not spontaneously draining
            - Painful
        - Procedure
            - Soak roller gauze in cold water and use it to completely cover all exposed skin around the nail plate (paronychial folds and eponychium)
            - Place hot cautery device over center of hematoma and apply gentle pressure until a pop is felt (blood will begin to drain)
                - Repeat if need to assure hematoma is draining
            - If directed by telemedicine practitioner, refer patient for x-ray
    - Discharge for wound management
        - Update tetanus immunization status if indicated per telemedicine practitioner.
        - Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Superficial (minor) First- and Second-Degree Burns

While major burns require emergency department evaluation, many minor burns including small superficial second-degree burns can be managed locally.

Contraindications

- Second degree burns with blisters that cross joints.
- Second degree burns of the face or genitals.

Procedure

- Stop the burning process by cooling the site if needed.
- First degree burns
    - Apply topical anesthetic as directed.
- Second degree burns
    - Apply topical anesthetic as directed.
    - Intact blisters
        - Pad for protection
    - Ruptured blisters
        - Perform local anesthesia as directed.
        - Debride ruptured blisters as directed.
    - Apply topical antibiotic ointment to ruptured blister sites.
    - Dress with sterile, non-stick dressings.
    - Update tetanus vaccination if ordered by telemedicine practitioner.
- Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Friction Blisters

Friction blisters can be debilitating. However, they are easily managed for comfort and function.

Procedure

- Intact blisters that are non-painful and do not impact function.
    - Pad to protect.
- Intact blisters that are painful or that impact function
    - Prep the overlying skin of the blister.
    - Aspirate the blister fluid.
        - If the blister is large, consider multiple aspiration punctures to improve drainage,
    - Dress with sterile dressing
        - Apply antibiotic ointment only if ordered by telemedicine practitioner.
- Provide patient with appropriate written / electronic discharge instructions.

Soft Tissue Injury Management: Soft tissue infections including superficial abscess

While cellulitis can be treated with an antibiotic, once an abscess has formed, it will only resolve with drainage.

Procedure

- Complete the General Patient Management Process
- Perform soft tissue ultrasound to confirm presence or absence of a drainable abscess.
- Contact telemedicine practitioner for soft tissue infection co-evaluation and management plan.
    - If a superficial abscess is identified, perform needle aspiration under ultrasound guidance if ordered by telemedicine practitioner.
        - Incision and drainage is NOT permitted.
    - Administer antibiotics as directed.
    - Discharge for wound management
        - Update tetanus immunization status if indicated.
        - Provide patient with appropriate written / electronic discharge instructions.

Extremity Injury Management: Sprains, strains, and possible fractures

Extremity injuries can generally be divided into deformed injuries and non-deformed injuries. In the absence of X-ray capacity, assessment is limited to physical. The management of extremity injuries will therefore tend to be more conservative. The goals should be to minimize the risk of harm and maximize future function.

Procedure

- Non-deformed neurovascularly intact injured extremity
    - Contact telemedicine practitioner for co-evaluation and management discussion.
        - Provide protection (splinting, slings, etc.) as indicated.
            - Critical Access Practitioner Extender may NOT apply circumferential fiberglass splinting materials.
        - Basic procedure
            - Use commercial splint if directed.
            - Use fiberglass splinting material if directed.
        - Specific splints
            - Long arm posterior
            - Volar
            - Sugar tong / U splint
            - Posterior ankle splint
        - Apply ice and use elevation for symptom control.
        - If patient will not be transported, make arrangements for referral for follow up and radiographs as directed by telemedicine practitioner and per local process.
        - Contact telemedicine practitioner to evaluate the splint prior to discharge.
        - If discharge is appropriate, provide patient with appropriate written / electronic discharge instructions.

For any splint placement, complete pre and post splint neurovascular assessment and contact the telemedicine practitioner to evaluate the splint prior to discharge.

Extremity Injury Management: potential isolated dislocation of an interphalangeal, shoulder, or patella

Dislocations are typically most easily reduced in the acute injury period. Interphalangeal, patella, and shoulder dislocations may be reduced without procedural sedation.

Contraindications

Shoulder reduction:

1. Any direct trauma to the shoulder.
2. Fall on an outstretched hand mechanism of injury.

Procedure

- In all cases, provide protection (splinting, slings, etc.) post-procedure and arrange follow-up as discussed with telemedicine practitioner.
    - Finger
        - Contact telemedicine practitioner for co-assessment and management discussion.
        - Perform digital block if indicated (see "Local Anesthetic Techniques")
        - Proximal and Distal Interphalangeal joints
            - Perform traction-manipulation reduction,
            - Telemedicine practitioner to evaluate post-reduction alignment,
            - Place appropriate splint as per "Extremity Injury Management: fracture or possible fracture dislocation."
            - If ordered by telemedicine practitioner, arrange for follow-up for x-ray referral as per local process.
            - Provide patient with appropriate written / electronic discharge instructions.
    - Patella
        - Perform long bone ultrasound of proximate bone structures to evaluate for fracture
        - Contact telemedicine practitioner for co-assessment and management discussion
        - Provide analgesia as per Maine EMS protocols if necessary
            - Usually reduction can be done without analgesia
        - Perform reduction as per p. 1021 (Figure 49.64)
            - Simplest technique is to
                - Raise the bed to maximum height
                - Hold the patient's heel at that level
                - Slowly lower the bed until the leg straightens
                - If reduction does not occur at that point
                    - Prop the leg up at that height
                    - Manipulate patella as per p. 1021
        - Telemedicine practitioner to evaluate post reduction restoration of anatomic alignment
        - Splint with knee immobilizer
        - Arrange for follow-up for x-ray referral as per local process.
        - Provide patient with appropriate written / electronic discharge instructions.
    - Anterior shoulder
        - Key points
            - May be difficult to distinguish from a proximal humeral fracture

- Dislocation is a disease of the younger, fracture a disease of the older
- Many fresh, recurrent shoulder dislocations can be reduced without analgesia
- Reduction is not about forcing the humeral head back into the joint but rather about fatiguing the muscles is spasm to allow it to slip back in place.

- Contact telemedicine practitioner for co-assessment and management discussion.
- Provide analgesia as per Maine EMS protocols or per telemedicine practitioner guidance.
    - Procedural sedation is NOT permitted.
- Technique
    - Prakash maneuver
        - Patient sits upright in chair, bed, or stands against a wall to fix scapula.
        - Hold elbow and wrist.
        - Gradually rotate arm externally until arm is in coronal plane.
            - Hold arm in this position for at least 1 minute.
        - Gradually adduct the elbow until it overlies the chest.
        - Internally rotate the arm until the hand touches the opposite shoulder
    - Stimson technique
        - Notes:
            - Secure patient to stretcher
            - Monitor airway status
            - Prevent from falling off bed
            - May take 30 minutes
    - External Rotation technique
        - Adduct elbow
        - Gently externally rotate the arm
            - Not a lever
            - Rotation force is the weight of the arm plus the weight of the Critical Access Practitioner Extender's hands
            - Stop every time the patient experiences pain
            - Reduction occurs at 75^{o}-110^{o}
            - Do not apply traction to the arm
        - If unsuccessful, gently abduct the arm without traction into the Milch technique.
    - Milch technique
        - Abduct the arm to an overhead position.
            - Patient may be able to abduct on their own by placing hand behind head.
        - Apply gentle traction along the long axis of the arm and rotate the arm externally (clockwise if you are looking at the palm of the hand)
            - The final position is what the arm would look like if the patient were reaching up into a tree to pick an apple.
        - If an assistant is available, may need to push the humeral head upward into the glenoid fossa .
    - Cunningham technique
        - Inform patient this is a painless technique

    - Sit patient with the back vertical, preferably in a chair without wheels or arms
    - Allow patient to assist with arm positioning
        - Arm hanging by side, palm anterior, adducted
        - Flex elbow to 90^{o}
    - Position yourself
        - Squat, kneel, or sit beside the patient's affected limb facing in the opposite direction of the patient
        - Tuck your hand between the patient's forearm and body so the patients hand is resting on your upper arm
            - Do not make any pulling motions
        - Use your forearm to apply gentle and continuous downward traction on the patient's forearm
            - The combined weight of the two arm may be sufficient
        - With you other arm, begin sequentially and firmly massaging the trapezius, deltoid, and biceps muscles
            - Focus on the biceps brachii
                - Thumb on biceps, fingers wrapped posteriorly
            - Repeat the trapezius – deltoid – biceps sequence as needed
        - There may not be a definitive endpoint so when the step-off disappears, check range of motion
- If unable to reduce
    - Refer to emergency department
    - If patient is not being transported by EMS, contact telemedicine practitioner for co-management discussion
- Post-reduction
    - Assess neurovascular status
    - Put shoulder through gentle range of motion
    - Apply a sling
- If patient will not be transported, if ordered by telemedicine practitioner, make arrangements for referral for follow up and radiographs per local process
- If discharge is appropriate, provide patient with appropriate written / electronic discharge instructions.

Ultrasound

Ultrasound is a useful tool for the assessment of a variety of complaints and to guide management of ill and injured patients. Although there are almost unlimited uses of ultrasound, the Critical Access Practitioner Extender is restricted to those procedures for which training and credentialing has been completed. Ultrasound may be used as part of the initial focused evaluation or as directed by the telemedicine practitioner.

Procedure

- When appropriate in the examination, perform one or more of the following ultrasound studies and save images securely to share with telemedicine practitioner.
    - Soft tissue
        - Obtain and upload views of appropriate depth to visualize abscess and cellulitis
            - Typically to the depth of an underlying solid structure

Otolaryngologic Care: Ear foreign body removal

Ear, nose, and throat complaints are common. Being able to perform a complete exam and perform some simple procedures can stabilize or mitigate most of these complaints

Procedure

- Contact telemedicine practitioner for co-assessment and management discussion
    - Perform otolaryngologic procedures as indicated
        - Ear foreign body removal
            - Indication: Foreign bodies in the EAC that can be visualized without an otoscope
            - Always assess hearing before and after the procedure
            - Perform topical ear anesthesia as directed
            - Use the most appropriate technique
            - Provide patient with appropriate written / electronic discharge instructions.

Epistaxis Management

Definitive control of epistaxis bleeding is typically achieved through a combination of direct pressure +/- topical medication administration.

Procedure

- Epistaxis management
  - Identify if the bleeding is unilateral or bilateral
  - Instill 4 sprays of oxymetazoline nasal spray in each nostril
  - Place a nasal clamp for external compression for 15 minutes
  - After 15 minutes remove the nasal clamp
    - If bleeding is controlled
      - Contact telemedicine practitioner for co-assessment and discharge options
    - If bleeding is not still not controlled
      - Arrange transfer to emergency department

Ophthalmologic Care

Eye disease are common triggers for emergency and urgent assessment. Key considerations in management include presence or absence of vision loss, signs of significant infection, and presence or absence of vision threatening injuries.

Procedure

- Perform visual acuity testing
- Perform ophthalmological anesthesia for pain
    - Instill 2 drops of tetracaine 0.5% solution in each eye
- Contact telemedicine practitioner for co-assessment and management options
    - Fluorescein examination
        - Moisten fluorescein strip with sterile water or tetracaine 0.5% solution
        - Apply thin layer to lower lid and have patient blink
        - Use Wood's lamp or Eidolon Bluminator for exam.
    - Eyelid eversion
        - Have patient close eye
        - Place a cotton tip applicator on the mid-upper eyelid
        - Using the lashes for traction, fold the lid over the cotton tip applicator
    - Ocular irrigation
        - NOTE: All patients who undergo ocular irrigation for a chemical exposure MUST go to an emergency department for a definitive evaluation
        - Perform per MEMS Green 23 "Ophthalmology"
        - Perform ophthalmologic anesthesia
        - Measure eye pH for acid or alkali exposure if pH paper is available
        - If available, use a Morgan Lens technique, otherwise
        - Cut the IV tubing off a maxi-drop drip set just distal to the drip chamber
        - Insert the cut end of the tubing into the flowmeter end of nasal cannula
        - Tape nasal cannula to the bridge of the nose with one prong on either side of the nose
        - Spike a warmed bag of saline or LR
        - Irrigate through the nasal cannula
        - Instill at least one liter and then as directed by the telemedicine practitioner
        - For acids or bases, irrigate until the pH reaches 7-7.5
    - Superficial foreign body removal
        - Indication: Visible corneal, scleral, or lid foreign body
        - Always consider the mechanism for the possibility of a penetrating intraocular FB
        - Technique
            - Contact telemedicine practitioner
                - Discuss the need for tetanus vaccination
                - Discuss the need for ophthalmic antibiotics
            - Perform ophthalmologic anesthesia
            - Irrigate per MEMS Green 23 "Ophthalmology"
            - If foreign body is on an eyelid
                - Evert eyelid
                - Sweep off foreign body with a cotton tip applicator
    - Determine follow-up plan per local process
    - Provide patient with appropriate written / electronic discharge instructions.

Practitioner Directed Administration of Medications

As part of the routine care of urgent and emergency patients, telemedicine practitioner may direct the Critical Access Practitioner Extender to administer oral, otic, ophthalmic, topical, IM, or IV medications outside of these specific protocols and outside of the MEMS protocols including and limited to antibiotics, ophthalmic antibiotics, otic antibiotic and antibiotic combination medications, thrombolytics (and associated medications for thrombolysis in STEMI), and analgesics including topical and oral mucous membrane local anesthetics. Telemedicine practitioner will make the final determination of dose and route for these medications.

Procedure

- Verify the medication dose, route, and administration instructions with the telemedicine practitioner.
- Consult the approved medication reference for confirmation
- Review indications, contraindications, and precautions and assure that the medication is appropriate
    - Contact telemedicine practitioner with any questions
- Administer the medications as ordered
- Monitor patient for unintended effects

Laboratory Sample Collection and Analysis

For urgent care patients, certain laboratory studies are useful for the evaluation and treatment of common complaints. While the analysis is specific to the equipment vendor, generally sample collection is standard across all tests of a single type. It is critical that any routine equipment diagnostic tests and control testing be completed per the equipment manufacturers' guidance.

Procedure

- Oropharyngeal swab for streptococcal pharyngitis.
  - Collect oropharyngeal sample per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- Swab for influenza.
  - Collect nasopharyngeal sample per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
    - Note: These may be combination viral respiratory tests depending on the manufacturer (e.g. influenza, COVID 19, and RSV).
    - If that is the case, all results may be reported to the ordering practitioner
- Urinalysis
  - Provide patient instructions for clean catch urine sample collection
  - Run test and appropriate controls per test manufacturer's instructions.
- Urine pregnancy test
  - Provide patient instructions for clean catch urine sample collection
  - Run test and appropriate controls per test manufacturer's instructions.
- Mononucleosis testing
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- Hemoglobin and hematocrit
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- White blood cell count
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- INR
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- Liver function tests
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- Basic metabolic profile with electrolytes
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- Venous blood gas
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.
  - Run test and appropriate controls per test manufacturer's instructions.
- Lactate
  - Collect blood sample (fingerstick preferred if permitted) per test manufacturer's instructions.

- Run test and appropriate controls per test manufacturer's instructions.

Critical Access Practitioner Extender Formulary

In addition to those medications and routes within the formulary of the Critical Access Practitioner Extender's primary EMS license, the Critical Access Practitioner Extender is authorized to administer medication in the following classes and routes. Additionally, if the Critical Access Practitioner Extender holds a concurrent Community Paramedicine License, their formulary also includes the Community Paramedicine Formulary for their Community Paramedicine License Level.

Class	*Route(s)*
Antibiotics	Oral, IV, IM, Ophthalmic, Otic, Topical
Antivirals	Oral
Antiemetics	Oral, IV, IM, Rectal
Non-opiate analgesics	Oral, IV, IM
Steroids	Oral, otic (in combination medications)
Local anesthetics	SQ / intra-wound, intradermal, topical, transmucosal
Ophthalmic fluorescein	Ophthalmic
Ophthalmic anesthetic	Ophthalmic
Antihistamines	Oral
Booster tetanus vaccination (TD, Tdap)	IM
Decongestant administration	Oral, IN

The Critical Access Practitioner Extender, in accordance with the Mane Board of Pharmacy Rules Chapter 20, Subchapter 1, Section 3, either as "a person legally qualified under a health practice act to administer drugs" or through formal registration as a Pharmacy Technician, in a contractual relationship with a licensed pharmacy, may dispense prescription medications through an Automated Pharmacy System.

Proposed Critical Access Practitioner Extender Scope of Practice V1.0

In addition to those medications/routes and procedures within the formulary and scope of practice (protocols) of the Critical Access Practitioner Extender's primary EMS license, the Critical Access Practitioner Extender is authorized to perform the following procedures in the context of a Critical Access Practitioner Extender Audio / Video (including store and forward) telemedicine encounter.

Approved procedures

1. Audio/Video telehealth facilitation
    a. Audio / Video teleconferencing
    b. Realtime and store and forward peripherals
        i. Still image
        ii. Video
        iii. Audio
2. Local anesthetic administration
    a. Intra-wound injection
    b. Field block (not isolated nerve block)
    c. Digital block (fingers and toes; only approved specific nerve blocks)
    d. Transcutaneous / topical
    e. Mucosal
3. Soft Tissue Injury management
    a. Wound cleaning and preparation including limited debridement
    b. Primary wound closure
        i. Single layer suturing in include interrupted and running sutures
        ii. Staple closure
        iii. Skin tape (e.g. Steri-Strips®)
        iv. Topical skin adhesive
    c. Wound preparation for delayed primary closure or closure by secondary intention
        i. The intention is not for the CAPE to perform the delayed primary closure but rather for the CAPE to clean and perform limited debridement of the wound in preparation for another clinician (e.g. qualified healthcare practitioner) to perform the delayed primary closure
    d. Burn management including limited debridement of ruptured blisters
    e. Friction blister management including aspiration of painful / function-limiting blisters
    f. Removal of superficially embedded cutaneous foreign bodies
        i. Embedded fishhooks except the eye or genitals
        ii. Embedded splinters 1mm in diameter or less
        iii. Attached ticks using a scoop-style removal device (e.g. Tick Spoon®) or forceps traction
    g. Electrocautery trephination of subungual hematoma
4. Extremity injury management
    a. Application of commercial manufactured splints
    b. Fiberglass splinting
        i. Long arm posterior
        ii. Volar

iii. Sugar tong / U-splint
iv. Posterior ankle splint

c. Potential dislocation reduction
i. Interphalangeal joint
ii. Patella (not knee)
iii. Shoulder
1. No mechanism of direct trauma to include fall on outstretched hand

5. Soft tissue infection management
a. Soft tissue ultrasound evaluation of cellulitis and potential abscess
b. Ultrasound confirmed and guided needle aspiration of superficial cutaneous abscess
6. Otolaryngologic care
a. Distal external auditory canal foreign body removal (foreign body must be visible without an otoscope)
b. Epistaxis management
i. External compression
ii. Oxymetazoline administration
7. Ophthalmologic care
a. Physical examination facilitation
i. Fluorescein application
ii. Eyelid eversion
b. Foreign body removal
i. Sweeping everted eyelid with cotton-tipped applicator to remove visualized foreign body
ii. Ophthalmic analgesia and flushing to remove superficial conjunctival and corneal foreign bodies (already within the scope of a paramedic under MEMS protocols)
8. Laboratory testing
a. Viral respiratory swab
b. Urinalysis (“urine dip”)
c. Urine pregnancy test
d. Mononucleosis test
e. Oropharyngeal streptococcal test
f. Hemoglobin and hematocrit
g. White blood cell count
h. INR
i. Liver function tests
j. Basic metabolic profile with electrolytes
k. Venous blood gas
l. Lactate

Proposed Critical Access Practitioner Extender Scope of Practice V1.0

Notes to be deleted in final published document:

Items highlighted in yellow represent an expansion from the pilot project Critical Access Practitioner Extender scope of practice and are recommended based on being low risk, low complexity, common urgent care procedures.

Emergency procedures (TNK for STEMI and POCUS IV placement) are removed from this proposed list as they are better suited to be included in the Maine EMS Emergency Medical Care Protocols.

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REVIEW ARTICLE

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Comparing running vs interrupted sutures for skin closure: A systematic review and meta-analysis

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Abstract

Continuous sutures and interrupted sutures have been widely applied to skin closure after non-obstetric surgery or traumatic wounds. Usually, continuous sutures were divided into transdermal or subcuticular sutures according to whether the stitches were placed through or below the epidermal layer. Interrupted sutures, on the other hand, involved penetration of the loose connective tissue beneath the skin layers, with stitches placed through the external skin layer. Complications including infection, dehiscence, and poor cosmetic appearance were not rare after suturing. Whether a suture method is a suitable option for rapid wound healing and long-term cosmetic appearance remains controversial. To examine the potential benefits and harms of continuous skin sutures vs interrupted skin sutures in non-obstetric surgery or traumatic wounds. Searching websites such as PubMed, the Cochrane Central Library, Web of Science and Embase, and ClinicalTrials.gov were systematically searched up to 5 January 2022 and were assessed and guided by Preferred Reporting Items for Systematic Reviews and Meta-analysis rules as well as guidelines. All relevant randomised controlled studies comparing continuous sutures with interrupted sutures of skin closure were analysed. The suture techniques and material used in each trial were recorded. The transdermal and subcuticular continuous sutures were separately compared with interrupted sutures in the subgroup analysis of dehiscence and cosmetic appearance because the visual appearance of these two continuous suturing techniques was significantly different. Ten studies including 1181 participants were analysed. Subcuticular continuous sutures had comparatively higher visual analogue scale (VAS) scores among patients and doctors than interrupted sutures (OR = 0.27, 95% Confidence Intervals [CI] = 0. 07-0.47, $P < .01$). Similarly, priority was found regarding transdermal continuous sutures and interrupted sutures (OR = 0.40, 95% CI = 0.21-0.60, $P < .01$). Five randomised controlled trials (RCTs) demonstrated relevant data about dehiscence events. The incidence of continuous suture was significantly lesser than that of interrupted suture (OR = 0.16, 95% CI = 0.07-0.37, $P < .01$). There was no significant difference

between the infection events rates of two suture methods (OR = 0.69, 95% CI = 0.40-1.21, $P = .62$, $I^2 = 0\%$). This systematic review indicated the superiority of both transdermal and subcutaneous continuous sutures over interrupted sutures in skin closure in terms of wound healing and cosmetic appearance.

KEYWORDS

complication events, continuous suture, cosmetic appearance, interrupted suture, wound healing

Key Messages

- This meta-analysis and systematic review demonstrated the superiority of continuous suture over interrupted suture in skin closure in terms of wound healing and cosmetic appearance.
- To our knowledge, this is the first meta-analysis providing insight into whether continuous skin sutures result in a better cosmetic appearance.
- Our research demonstrates that the use of continuous suturing reduces superficial wound dehiscence and improves cosmetic satisfaction. We recommend that clinicians place more emphasis on continuous sutures when both suturing techniques are available for skin wound closure. When dealing with skin closure in high tension areas, an intracutaneous continued suture is a better method to reduce the complications of the wound opening. In terms of the scar cosmetic appearance, running suturing is also more appealing for both surgeons and patients.

1 | INTRODUCTION

Skin suturing is one of the basic procedures in all surgeries. It promotes early wound healing, which is an essential process of scar formation. The permanent scar formed after wound healing will significantly affect the mental health, personal relationships, and quality of life of patients.[1] According to Moy et al, the ideal skin suture is rapid and straightforward, providing sufficient tensile strength to the wound until it heals, and the wound edges are accurately anastomosed to avoid scar hyperplasia.[2] The appropriate suture can reduce wound complications and scar hyperplasia, therefore achieving better cosmetic outcomes.[3]

Suture methods can be basically categorised into two groups: continuous sutures and interrupted sutures. When using interrupted sutures, surgeons can control the suture spacing between two ends of the wound because each stitch is composed of a single piece of material. By comparison, continuous sutures have the nature of having uniform tension during the whole length of the wound.

The short-term complications after skin suture include dehiscence and infection. Most studies on sutures have focused on infection because it is the most common complication in all operations.[4] Disinfection, antibacterial treatment, and infection prevention are essential in all surgeries. With the development of surgical skills and long-term complications, scar appearance and pigmentation development are also raising both surgeons' and patients' concerns. Most of the outcome reports on the cosmetic evaluation of scars are based on subjective scar scores. The visual analogue scale (VAS) is a reliable and effective instrument for measuring differences and changes in scar quality.[5]

Apart from continuous or interrupted techniques, the skin layers involved (transdermal or subcuticular) and suture material used may also play essential roles in the outcomes. In general, interrupted sutures involve the whole skin layer. Continuous subcutaneous sutures, contrasting with continuous transdermal sutures, were stitches placed immediately below the external skin layer and offered benefits of better aesthetic outcomes.[6] Dehiscence rate remained unclear whether subcutaneous or transdermal sutures would be different.[7] For these reasons, we carry out a subgroup analysis to separately compare continuous subcutaneous or transdermal sutures with interrupted sutures in this study. The infection rate was similar in subcutaneous and transdermal continuous sutures,[8,9] so they were analysed within the same group. Sutures materials can be divided into two main types, absorbable or non-absorbable. Continuous suture materials are absorbable, while interrupted sutures are mostly unabsorbable.[10] The suture material seemed to be linked with the choice of suture technique. Given that there was evidence showing no significant differences in two suture materials in the incidence of complication events and

cosmetic appearance,[11-13] the primary determinant is still the method of skin closure.

Current researchers had conflicting opinions when comparing the two suture methods. For instance, some surgeons believed interrupted sutures had the advantage of providing more tensile strength and thus less dehiscence.[14] However, some argued that interrupted sutures would develop dehiscence if the wound edges were overlapped.[10] Therefore, which suture method is more suitable for wound suture remains controversial. This study searched randomised controlled trials (RCTs) comparing continuous sutures and interrupted sutures. We discussed the differences in the incidence of infection and dehiscence, cosmetic outcome, and suturing time between the two suture methods to offer a proposal for surgeons in suture methods.

2 | METHODS

This study was directed by the rules of the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement.[15]

2.1 | Search selections

Relevant studies from PubMed, the Cochrane Central Library, Embase, and Web of Science to 5 January 2022 were searched. Moreover, we conducted a manual search of all relevant references in the literature. For those relevant databases, we used the search strategy about the medical subject headings (MESH); 'Suture Techniques', 'interrupted suture', 'continuous suture', 'running suture', 'suture', 'suturing', 'comparative study', 'prospective studies', 'clinical trial', 'randomized/randomized controlled study' and 'Human'. The language was restricted to English only. We strictly limit searched articles to RCTs. All potentially eligible studies were performed and checked by two researchers independently. Disagreements and controversies between reviewers were discussed and resolved by collective consensus.

2.2 | Inclusion and exclusion criteria

2.2.1 | Inclusion criteria

1. Study type: RCTs published in full peer-reviewed journals up to 5 January 2022 were included in the analysis.
2. Language: Only English articles were included.
3. Intervention: Two different suture techniques for skin suture, continuous suture (both transdermal and subcutaneous) vs interrupted suture, were assessed for the short-term and long-term differences in surgical outcomes. Suture material could be different. The issues of difference between subcutaneous and transdermal continuous sutures in dehiscence rate and cosmetic appearance were resolved by subgroup analysis.
4. Included patients: Patients who needed skin sutures for traumatic wounds or non-obstetric surgery were included in the meta-analysis.

2.2.2 | Exclusion criteria

1. Not RCTs or studies unpublished were excluded.
2. Suturing techniques are applied not for skin closure, such as in obstetric surgery and abdominal fascial closure.
3. Without relevant outcome.

2.3 | Outcomes of analysis

The primary outcome measure included (a) VAS of the scar cosmetic appearance after long-term follow-up, evaluated by both professional doctors and patients; (b) the incidence of dehiscence; and (c) the infection rate. The secondary outcome measure was the suturing time. Other outcome variables, such as edema intensity, hospital stay, and pain intensity, were not analysed because of insufficient data.

2.4 | Data collection

We extracted the baseline characteristics and outcome information: the first author, published the year of study, type of surgery, number of participants, suture techniques, suture methods, suture material, and all the relevant outcomes. The information was extracted from included RCTs and double-checked by two individuals. If there are controversies, a third reviewer will reach the final discussion until we agree.

2.5 | Quality of evidence assessment

Two independent authors reviewed all RCTs. They assessed the quality and eligibility of the selected studies blindly, according to the guidelines of the Critical Appraisal Skills Programme (CASP) Checklist. If they cannot reach a consensus, we establish a group discussion with a third assessor. The CASP Checklists assess the bias risk and comprise 11 items for evaluation (Table S1). Each study was allocated a score from 0 to 11, with 0 representing the lowest quality and 11 representing the highest based on the following

aspects: reporting of randomization, blinding, methodological quality, and statistical reporting. Each item was scored 1, 0.5, and 0 to represent the meaning of 'Yes', 'Not sure', and 'No', with a maximum score of 11. Trials with a score of over 8 were regarded as high-quality RCTs.

2.6 | Statistical data analysis

We used the newest version of analysis software: Cochrane Collaboration's Review Manager Program (RevMan version 5.4; Cochrane Collaboration, Oxford, UK). For continuous data, the mean and deviation of each study are required. We analysed the odds ratios (ORs) with 95% CIs. Tests of heterogeneity (I^2 index) for outcomes were performed. When discussing the incidence of dehiscence and cosmetic appearance, the difference of continuous transdermal or subcutaneous sutures vs standard interrupted sutures was separately investigated in subgroup analysis. Fixed-effects or random-effects models were used accordingly to combine the summary data. We analysed the publication bias by funnel plots. Statistical heterogeneity was tested with the χ^2 test and I.^{2} P values for tests of hypotheses on the study variables were reported. The effect was statistically significant if the P-value was $\leq$5%.

3 | RESULTS DEMONSTRATION

A flow-process diagram of the article search is demonstrated in Figure 1. First and foremost, through the direction of the database search strategy, we identified 49 478 potentially eligible articles. Non-RCTs were excluded in the first move, leaving 1992 articles. Then those 1992 articles were further selected after careful reading of the abstracts. Among the process, 1910 articles were excluded because comparisons of suture materials or other suture techniques were made instead of continuous and interrupted sutures. After thorough and detailed insights into these 82 full-text articles, 18 studies were eliminated because participants were women after vaginal birth or perineal injuries, 32 studies of fascial, soft tissue, vascular or muscle suturing, and 7 studies of corneal suturing were excluded. Eleven studies were excluded because comparisons were not made between continuous sutures and interrupted sutures, 2 studies were excluded because the original manuscripts were retrieved, and 1 study was excluded because it was not written in English. Two studies were further excluded because of lack of relevant outcomes. The remanent 10 RCTs were eventually brought into the final meta-analysis.

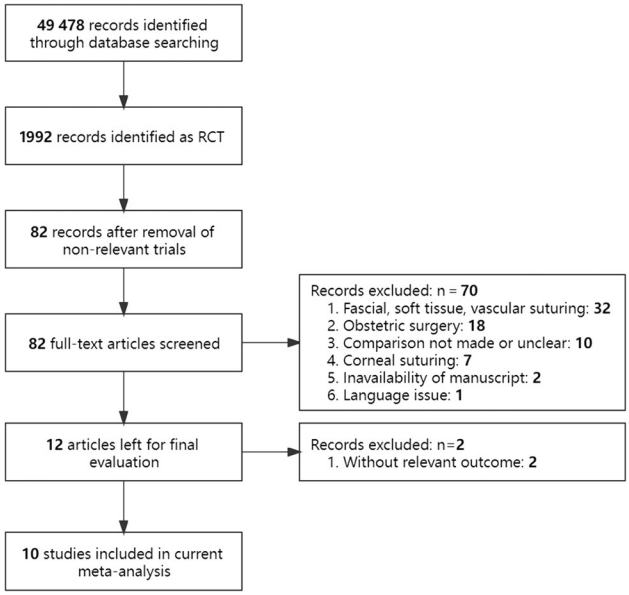

FIGURE 1 Flow diagram of the bibliographic search

3.1 | Study characteristics

The basic information and characteristics of the selected RCTs are presented in Table 1. Our systematic review and meta-analysis included 1181 participants. Among them, 529 patients were treated with continuous sutures, 551 patients were treated with interrupted sutures, and 101 patients were treated with both continuous sutures and interrupted sutures for half of the end of the same scar. The suturing technique and suture material are depicted in Table 2. Two trials compared continuous epidermal sutures and standard interrupted sutures. The left 8 trials studied intradermal/subcutaneous continuous sutures and interrupted sutures. Only one trial involved interrupted Donati stitches. In terms of suturing material, continuous sutures were likely to be absorbable, while interrupted sutures were generally non-absorbable. The quality evaluation of all included trials is demonstrated in Table 3.

3.2 | Primary outcomes

3.2.1 | Subgroup analysis of VAS

Six of the articles reported the VAS evaluation. In order to eliminate the influence and interference of the skin suture layer on appearance, we performed the subgroup analysis to exclude the interference factors and strongly prove the influence of suture mode on aesthetics. Four articles regarding the VAS evaluation between subcuticular or intradermal continuous sutures and traditional interrupted sutures found that continuous sutures

TABLE 1 Baseline information of randomised controlled trials (RCTs) enrolled in the meta-analysis

Study (Ref.)	Trial design	Type of surgery	Suturing place	Sample size	Drop-out rates	Sample size
Boutros S (2000)	RCT	Laceration and traumatic wounds repairing and closure	Scalp, face, upper extremity, lower extremity	119	6/101	Total = 95, Continuous = 42, Interrupted = 53
Anne K (2014)	RCT	Open acute appendicitis	Abdominal	206	51/193	Total = 137, Continuous = 69, Interrupted = 68
S Kot (2012)	RCT	Open appendectomy	A lower right abdominal incision	206	21/206	Total = 185, Continuous = 90 Interrupted = 95
Marco M (2014)	RCT	Sacrococcygeal pilonidal sinus	Sacral place	214	11/214	Total = 203; continuous = 100; interrupted = 103
Paul G. (1995)	RCT	Bypass surgery with a groin incision	Groin wounds	79	0/79	Total = 79, Continuous = 38, Interrupted = 41
Torben B (2009)	RCT	Single-portal endoscopic release of the carpal tunnel	The palmar side of the wrist	58	4/58	Total = 54, Continuous = 28, Interrupted = 26
Xiaomeng L (2017)	RCT	Conventional excision or Mohs micrographic surgery (MMS)	Face	142	13/142	Total = 129, Continuous = 62, Interrupted = 67
Marie-Michele Blouin , (2015)	RCT	Mohs micrographic surgery (MMS)	face	105	4/105	total = 101 (one person with both continuous and interrupted)
SL Pauniaho	RCT	Appendectomies with open technique	abdominal	198	28	Total = 198, continuous = 100, interrupted = 98
Judith D (2006)	RCT	A laparotomy for gynaecological diseases	lower midline abdominal	80	10/80	Total = 70; continuous = 37; interrupted = 33

have a comparatively higher VAS among patients and doctors than interrupted sutures (Std. Mean Difference = 0.27, 95% CI = 0.07-0.47, $P < .01$). Two articles regarding transdermal continuous sutures and standard interrupted sutures found a similar priority of continuous sutures (Std. Mean Difference = 0.40, 95% CI = 0.21-0.60, $P < .01$). Overall, continuous sutures have a comparatively higher VAS among patients and doctors than interrupted sutures (Std. Mean Difference = 0.34, 95% CI = 0.20-0.47, $P < .01$; Figure 2).

3.3 | Dehiscence

Five RCTs reported relevant data regarding dehiscence events. Subcutaneous continuous sutures were better in reducing the incidence of dehiscence events (OR = 0.16, 95% CI = 0.07-0.37, $P < .01$; Figure 3). Subgroup analysis was not conducted for lack of trials comparing continuous transdermal sutures and interrupted sutures.

3.4 | Infection events

The infection rates were reported in 9 RCTs. The overall infection rate was 4.4% (3.6% in the continuous suture group and 5.2% in the interrupted suture group). We did not find a significant difference in the infection rate between continuous sutures and interrupted sutures (OR = 0.69, 95% CI = 0.40-1.21, $P = .62$, $I^2 = 0\%$; Figure 4).

TABLE 2 Suture techniques and suture material of continuous or interrupted sutures in randomised controlled trials

Study	Skin layer	Continuous sutures technique	Interrupted sutures technique	Continuous suture material	Interrupted suture material
Anne K (2014)	Subcuticular	Continuous intradermal suture	Normal interrupted suture	Monocryl absorbable 4-0 monofilament suture	Ethilon non-absorbable 4-0
Judith D (2006)	Subcuticular	Continuous intradermal suture	Interrupted Donati stitches (vertical mattress stitches)	Monocryl 3-0	Ethilon 3-0
Marco M (2014)	Cuticular	Simple running suture	Normal interrupted suture	Absorbable 2-0 (Polyglytone 6211)	non-absorbable 2-0 (polyester)
M Blouin (2015)	Cuticular	Simple running suture	Normal interrupted suture	Vicryl/Ethicon 4-0 or 5-0 polyglactin 910	Vicryl/Ethicon 4-0 or 5-0 polyglactin 910
Torben B (2009)	Subcuticular	Subcuticular continuous suture	Normal interrupted suture	Caprosyn absorbable 4-0 polyglactin 6211 monofilament suture	Novafil non-absorbable 5/0 monofilament polybutester
Xiaomeng L (2017)	Subcuticular	Running subcuticular suture	Normal interrupted suture	non-absorbable monofilament sutures	non-absorbable monofilament sutures
Pauniaho (2010)	Subcuticular	Continuous intradermal suture	Normal interrupted suture	absorbable 4-0 polyglactin 910	non-absorbable 4-0 braided nylon sutures
S Kot (2012)	Subcuticular	Continuous intradermal suture	Normal interrupted suture	Monocryl absorbable 4-0 monofilament suture	Ethilon non-absorbable 4-0
Paul G (1995)	Subcuticular	continuous intradermal suture	Normal interrupted suture	Nylon (details not mentioned)	Nylon (details not mentioned)
Boutros S (2000)	Cuticular or subcuticular	Simple or subcuticular continuous suture	Normal interrupted suture	Nylon (details not mentioned)	Nylon (details not mentioned)

TABLE 3 Quality evaluations of randomised controlled trials finally included in the meta-analysis

Reference	Score of item I	Score of item II	Score of item III	Score of item IV	Score of item V	Score of item VI	Score of item VII	Score of item VIII	Score of item IX	Score of item X	Score of item XI	Total scores
Boutros S (2000)	1	0.5	1	0.5	0.5	0	1	1	1	1	1	8.5
Anne K (2014)	1	1	1	1	0.5	0	1	1	1	1	1	9.5
S Kot (2012)	1	1	1	1	0.5	0	1	1	1	1	1	9.5
Marco M (2014)	1	1	0.5	1	0.5	0	1	1	1	1	1	9
Judith D (2006)	1	1	0.5	1	0.5	0	1	1	1	1	1	9
Paul G (1995)	1	0.5	0.5	1	0.5	0	1	0.5	1	1	1	8
Torben B (2009)	1	1	0.5	0.5	0.5	0	1	1	1	1	1	8.5
Xiaomeng L (2017)	1	1	1	1	0.5	0	1	1	1	1	1	9.5
M Blouin (2015)	1	1	1	1	0.5	0	1	1	1	1	1	9.5
Pauniaho (2010)	1	1	0.5	1	0.5	0	1	1	1	1	1	9

3.5 | Potential publication bias

A funnel plot regarding the (a) VAS score, (b) the incidence of dehiscence, and (c) infection events are demonstrated in Figure 5, respectively. No apparent asymmetry was shown through the funnel plot, and only one study lays outside the limits of the 95% CI for dehiscence, and two studies lay outside for the VAS. No significant publication bias was noticed as all the studies were limited to other events.

4 | DISCUSSION

Our study compared the clinical and cosmetic outcomes of continuous and interrupted skin sutures. A total of 1181 participants in 10 independent RCTs were included in this meta-analysis and systematic review.[10,16-24] All the participants underwent traumatic wound repair or non-obstetric surgical skin closure. The sutures were at the scalp, face, upper or lower extremities, wrist, abdominal wall, groin area, or sacral region. Percutaneous or subcutaneous continuous sutures were separately analysed and compared with conventional interrupted sutures. The primary outcomes were infection, wound dehiscence, and cosmetic appearance VAS by both observers and patients. As mentioned above, suture material was not considered a potential bias as they have proven to have limited influence on primary outcomes.[11-13]

Overall, a total of 9 trials reported superficial wound infection. The infection was diagnosed by observing clinical signs and symptoms, such as redness, edema, discharge, or positive bacterial culture. A recent meta-analysis has showed no apparent difference between subcutaneous skin closure and no subcutaneous skin closure in developing wound infection.[9] Thus, subgroup analysis was not conducted. Our result indicated no significant difference in the proportion of participants between the two intervention groups. Notably, there was also no significant result in each trial. Therefore, suturing techniques have a slight impact on the incidence of superficial surgical site infection. Nevertheless, continuous sutures still have limitations. Once infection occurs, the whole stitch needs to be removed, hindering the healing process.[25-27] Pus could be drained by selectively removing a single stitch in interrupted sutures.

Participants in five different trials developed superficial wound dehiscence. The definition of dehiscence was not defined, although some experts described it as wounds open over 1 cm in one of the trials.[18] Overall, the difference between the two groups was significant, indicating that interrupted sutures were more likely to develop wound dehiscence than continuous subcutaneous sutures. The

difference was significant in 4 independent trials involving the abdominal wall.[10,18,20,21] The difference was not significant when the wound was sutured on the face.[22] A possible explanation is that in surgical wounds with high tensions, such as the scalp, abdominal wall, or extremities, interrupted sutures may have difficulty closing a defect when used under high stress on the skin because the wound edges have excessive tension.[28,29] The facial area (especially when the wound area is limited) is considered less tension, leading to no difference in the incidence of wound dehiscence between the groups. The possible explanation for the difference between the two groups is the overlapping of the wound edges caused by interrupted sutures, which continuous subcutaneous sutures can avoid. We may consider multiple factors concerning the reason for wound opening. More studies are needed to demonstrate the theories.

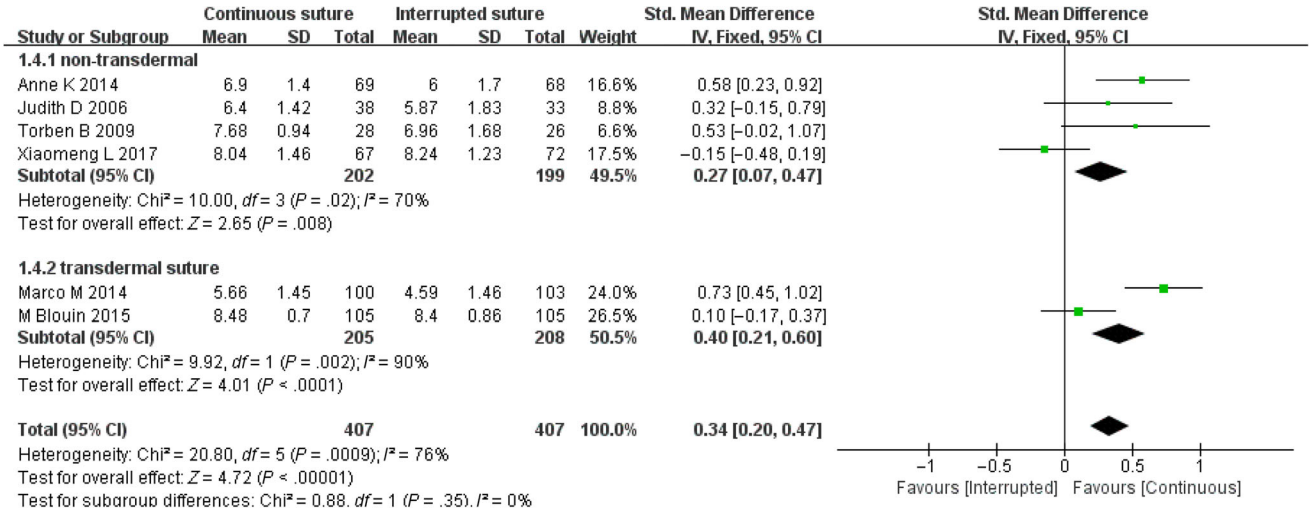

FIGURE 2 Forest plot of visual analogue scale subgroup analysis

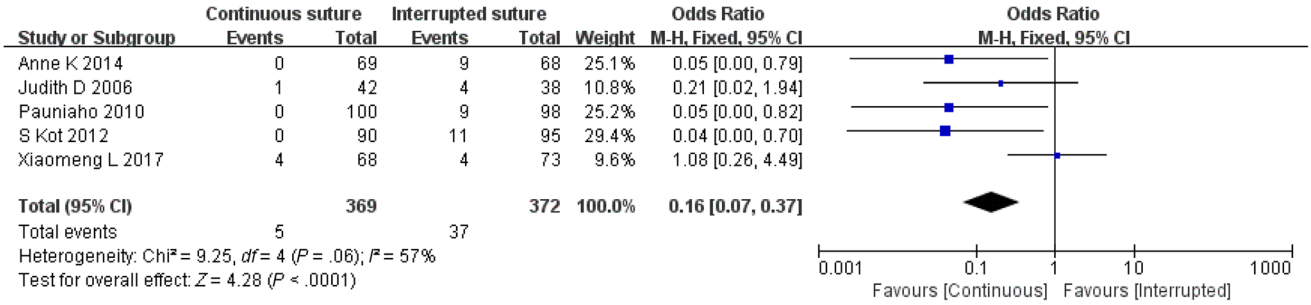

FIGURE 3 Forest plot of dehiscence events

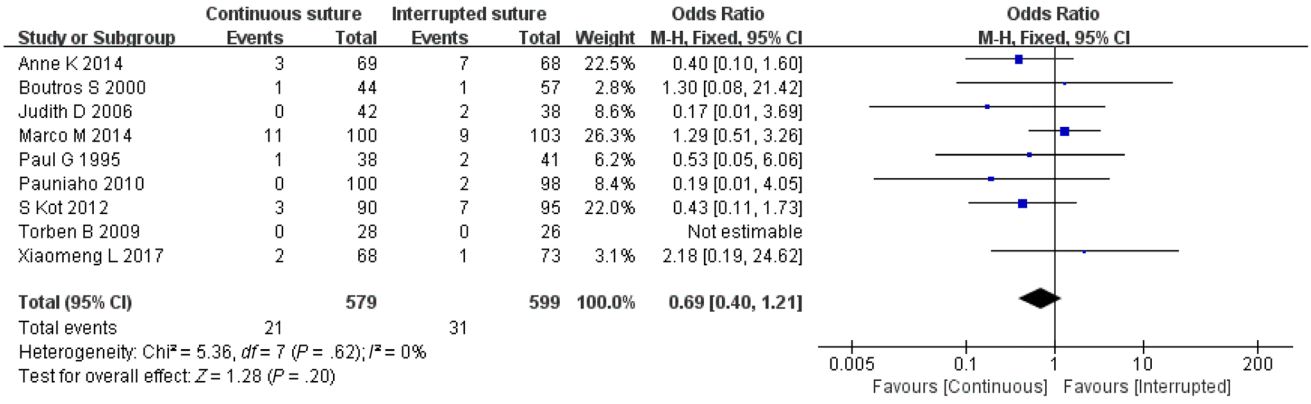

FIGURE 4 Forest plot of infection events

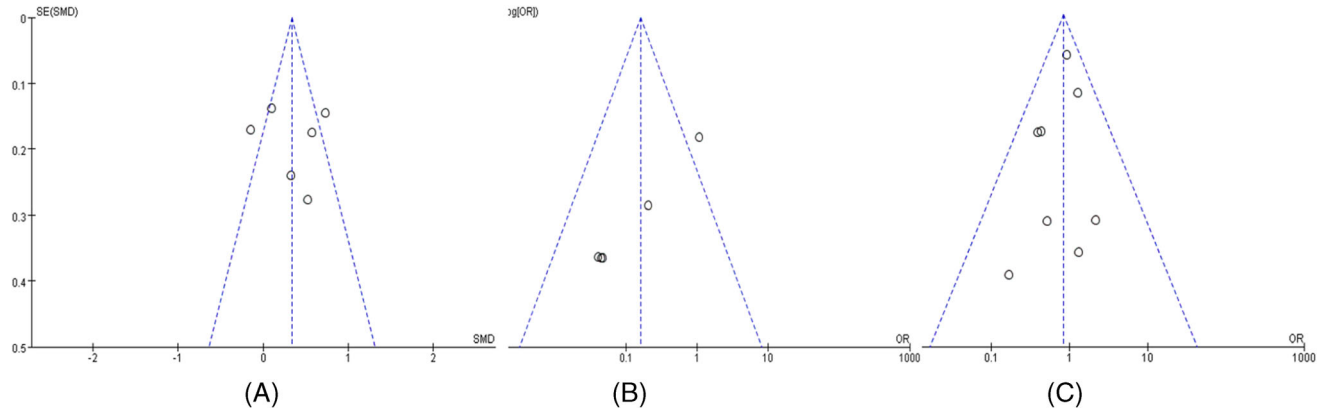

FIGURE 5 Funnel plot of (A) visual analogue scale score, (B) incidence of dehiscence, and (C) infection events

Previous studies investigating the association between suture techniques and cosmetic outcomes are limited. However, cosmetic satisfaction is sometimes even more important than the functional outcome of treatment,[30] playing an essential role in every aspect of our social life.[1] The VAS score of scar cosmetic appearance was reported in six trials by either professional observers or participants. We found that the cosmetic appearance was superior to continuous sutures, whether subcutaneous or percutaneous. Only one trial suggested that interrupted suture was slightly more relevant to a cosmetically superior outcome, with no significant importance.[22] The primary determinant of the cosmetic appearance of the scar in the paper is the method of skin closure.[31] It is generally believed that suture marks are associated with tissue inflammation macroscopically[31] and collagen fibre breakage[32] microscopically. Continuous subcutaneous sutures do not have stitches over the epidermal layer, resulting in no punctate scarring. In non-subcutaneous subgroup analysis, simple interrupted sutures, different from percutaneous running sutures, have to penetrate the epidermis to cause more inflammation. Continuous cutting and compression of soft tissue under normal skin can increase fibrous tissue during healing and centipede-like scarring. In addition, the suturing depth, width, and tensile strength might be difficult to be even because of the use of separate stitches, contributing to less precise epidermal alignment and a weakened cosmetic result.[2,32] The likelihood of dehiscence or the development of cross-scarring caused by interrupted suture may also affect the cosmetic result.[21,33]

The aesthetic evaluation of a scar is complicated. Several well-established scales that evaluate postsurgical scars have been applied to clinical practice.[34] Unfortunately, fewer than three pieces of work use these rating scales for primary outcomes. We used VAS as an alternative, consisting of a visual analogue cosmetic scale marked 'best-looking scar' at the top end and 'worst-looking scar' at the low end. Some may argue that the VAS assessment system is relatively arbitrary and subjective. However, a previous study showed an interobserver agreement of 0.75 to 0.87.[18] Additionally, good concordance between physician and patient assessments of scars has been demonstrated.[35] As both professional observers and patients evaluated the outcome on the same assessment scale, they were all included in the analysis.

Previous reviews have mainly concentrated on continuous vs interrupted sutures in obstetric surgery or episiotomy repair.[36,37] Suturing techniques usually require perfect closure of perineal muscle and soft tissue prior to skin closure. We excluded these studies because the different suturing techniques in soft tissue and muscle layers may cause bias. We also excluded abdominal fascia sutures in our study for the same reason.

To our knowledge, this is the first meta-analysis providing insight into whether continuous skin sutures result in a better cosmetic appearance. A relevant meta-analysis was reported in 2014 and included five independent studies.[38] Only two of the trials used the method of randomization and were also included in our study. The cosmetic results were not investigated because of the small number of articles included.

Our research demonstrates that continuous sutures reduce superficial wound dehiscence and improve cosmetic satisfaction. We recommend that clinicians emphasise continuous sutures when both suturing techniques are available for skin wound closure. When dealing with skin closure in high tension areas, subcutaneous continuous sutures are superior in reducing the complications of the wound opening. Running sutures are also more appealing for both surgeons and patients in terms of the scar cosmetic appearance. Continuous sutures are also time-saving in clinical routine.[39] One of the significant limitations of our study is that the trials in our VAS

subgroup analysis are limited, especially in the percutaneous group. Besides, we fail to conclude our outcome with more specific and comprehensive scar evaluation systems. The validity of the scar assessment needs to be improved by further studies.

Other complication events, such as symptoms of edema, swelling, pain and itchy and development of keloid scarring, hypertrophy and pigmentation, remain to be discussed. Recent trials have been carried out using a colourimeter to compare the colour difference between the suture area and the patient's own colour.[22,40] It is considered a more objective method to evaluate the intensity of edema and the development of pigmentation. Future trials with more extended follow-up periods are needed to assess the impact of the difference in skin suturing techniques from a more comprehensive perspective.

AUTHOR CONTRIBUTIONS

Wenhao Luo and Yinjie Tao contributed equally to this article. Study design: Wenhao Luo; Literature search: Yawen Wang and Zhaolian Ouyang; Study selection: Wenhao Luo, Yinjie Tao, Yawen Wang; Study draft and revision: Wenhao Luo, Yinjie Tao and Yawen Wang; Article guarantor: Dr Jiuzuo Huang and Dr Xiao Long; Project administration and Supervision: Dr Jiuzuo Huang and Dr Xiao Long.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

CONSENT TO PUBLISH

We exceedingly hope that this manuscript can be accepted and published.

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REFERENCES

1. Brown BC, McKenna SP, Siddhi K, McGrouther DA, Bayat A. The hidden cost of skin scars: quality of life after skin scarring. *J Plast Reconstr Aesthet Surg*. 2008;61:1049-1058. doi:10.1016/j.bjps.2008.03.020
2. Moy RL, Waldman B, Hein DW. A review of sutures and suturing techniques. *J Dermatol Surg Oncol*. 1992;18:785-795. doi:10.1111/j.1524-4725.1992.tb03036.x
3. Janis J, Harrison B. Wound healing: part II. Clinical applications. *Plast Reconstr Surg*. 2014;133:383e-392e. doi:10.1097/PRS.0000000000000077
4. Yag-Howard C. Sutures, needles, and tissue adhesives: a review for dermatologic surgery. *Dermatol Surg*. 2014;40(Suppl 9):3-15. doi:10.1097/01.DSS.0000452738.23278.2d
5. Duncan JAL, Bond JS, Mason T, et al. Visual analogue scale scoring and ranking: a suitable and sensitive method for assessing scar quality? *Plast Reconstr Surg*. 2006;118:909-918. doi:10.1097/01.prs.0000232378.88776.b0
6. Shin TM, Bordeaux JS. How suture technique affects the cosmetic outcome of cutaneous repairs. *J Drugs Dermatol*. 2014;13:967-969.
7. Goto S, Sakamoto T, Ganeko R, et al. Subcuticular sutures for skin closure in non-obstetric surgery. *Cochrane Database Syst Rev*. 2020;4:CD012124. doi:10.1002/14651858.CD012124.pub2
8. Tanaka A, Sadahiro S, Suzuki T, Okada K, Saito G. Randomized controlled trial comparing subcuticular absorbable suture with conventional interrupted suture for wound closure at elective operation of colon cancer. *Surgery*. 2014;155:486-492. doi:10.1016/j.surg.2013.10.016
9. Gurusamy KS, Toon CD, Davidson BR. Subcutaneous closure versus no subcutaneous closure after non-caesarean surgical procedures. *Cochrane Database Syst Rev*. 2014;21(1):CD010425. doi:10.1002/14651858.CD010425.pub2
10. Pauniaho SL, Lahdes-Vasama T, Helminen MT, Iber T, Mäkelä E, Pajulo O. Non-absorbable interrupted versus absorbable continuous skin closure in pediatric appendectomies. *Scand J Surg*. 2010;99:142-146. doi:10.1177/145749691009900308
11. Gillanders SL, Anderson S, Mellon L, Heskin L. A systematic review and meta-analysis: do absorbable or non-absorbable suture materials differ in cosmetic outcomes in patients requiring primary closure of facial wounds? *J Plast Reconstr Aesthet Surg*. 2018;71:1682-1692. doi:10.1016/j.bjps.2018.08.027
12. Al-Abdullah T, Plint AC, Fergusson D. Absorbable versus non-absorbable sutures in the management of traumatic lacerations and surgical wounds: a meta-analysis. *Pediatr Emerg Care*. 2007;23:339-344. doi:10.1097/01.pec.0000270167.70615.5a
13. Pereira JL et al. Skin closure in vascular neurosurgery: a prospective study on absorbable intradermal suture versus non-absorbable suture. *Surg Neurol Int*. 2012;3:94. doi:10.4103/2152-7806.99941
14. Azmat CE, Council, M. StatPearls. 2022.
15. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151:264-269, w264. doi:10.7326/0003-4819-151-4-200908180-00135
16. Blouin MM, Al Jasser M, Demanczuk A, Berkowitz J, Zloty D. Continuous versus interrupted sutures for facial surgery repair: a randomized prospective study. *Dermatol Surg*. 2015;41:919-928. doi:10.1097/DSS.0000000000000430

17. Boutros S, Weinfeld AB, Friedman JD. Continuous versus interrupted suturing of traumatic lacerations: a time, cost, and complication rate comparison. *J Trauma*. 2000;48:495-497. doi:10.1097/00005373-200003000-00021
18. de Waard J, Trimbos B, Peters L. Cosmetic results of lower midline abdominal incision: Donati stitches versus a continuous intracutaneous suture in a randomized clinical trial. *Acta Obstet Gynecol Scand*. 2006;85:955-959. doi:10.1080/00016340500433059
19. Hansen TB, Kirkeby L, Fisker H, Larsen K. Randomised controlled study of two different techniques of skin suture in endoscopic release of carpal tunnel. *Scand J Plast Reconstr Surg Hand Surg*. 2009;43:335-338. doi:10.1080/02844310902955763
20. Koskela A, Kotaluoto S, Kaartinen I, Pauniaho SL, Rantanen T, Kuokkanen H. Continuous absorbable intradermal sutures yield better cosmetic results than nonabsorbable interrupted sutures in open appendectomy wounds: a prospective, randomized trial. *World J Surg*. 2014;38:1044-1050. doi:10.1007/s00268-013-2396-8
21. Kotaluoto S, Pauniaho SL, Helminen M, Kuokkanen H, Rantanen T. Wound healing after open appendectomies in adult patients: a prospective, randomised trial comparing two methods of wound closure. *World J Surg*. 2012;36:2305-2310. doi:10.1007/s00268-012-1664-3
22. Liu X, Nelemans PJ, Frenk LDS, et al. Aesthetic outcome and complications of simple interrupted versus running subcuticular sutures in facial surgery: a randomized controlled trial. *J Am Acad Dermatol*. 2017;77:911-919. doi:10.1016/j.jaad.2017.04.1128
23. Milone M, Musella M, Maietta P, et al. Intradermal absorbable sutures to close pilonidal sinus wounds: a safe closure method? *Surg Today*. 2014;44:1638-1642. doi:10.1007/s00595-013-0741-z
24. Murphy PG, Tadros E, Cross S, et al. Skin closure and the incidence of groin wound infection: a prospective study. *Ann Vasc Surg*. 1995;9:480-482. doi:10.1007/BF02143863
25. Ashraf I, Butt E, Veitch D, Wernham A. Dermatological surgery: an update on suture materials and techniques. Part 1. *Clin Exp Dermatol*. 2021;46:1400-1410. doi:10.1111/ced.14770
26. Butt E, Ashraf I, Veitch D, Wernham A. Dermatological surgery: an update on suture materials and techniques. Part 2. *Clin Exp Dermatol*. 2021;46:1411-1419. doi:10.1111/ced.14812
27. Byrne M, Aly A. The surgical suture. *Aesthet Surg J*. 2019;39:S67-S72. doi:10.1093/asj/sjz036
28. Regula CG, Yag-Howard C. Suture products and techniques: what to use, where, and why. *Dermatol Surg*. 2015;41(Suppl 10):S187-S200. doi:10.1097/DSS.0000000000000492
29. Marsidi N, Vermeulen SAM, Horeman T, Genders RE. Measuring forces in suture techniques for wound closure. *J Surg Res*. 2020;255:135-143. doi:10.1016/j.jss.2020.05.033
30. Balaraman B, Geddes ER, Friedman PM. Best reconstructive techniques: improving the final scar. *Dermatol Surg*. 2015;41-(Suppl 10):S265-S275. doi:10.1097/DSS.0000000000000496
31. Gouletsou PG, Prassinos NN, Papazoglou LG, Kostoulas P, Galatos AD. Comparison of continuous intradermal with simple interrupted suture pattern: an experimental study in dogs. *Top Companion Anim Med*. 2020;41:100454. doi:10.1016/j.tcam.2020.100454
32. Richards PC, Balch CM, Aldrete JS. Abdominal wound closure. A randomized prospective study of 571 patients comparing continuous vs. interrupted suture techniques. *Ann Surg*. 1983;197:238-243. doi:10.1097/00000658-198302000-00018
33. Hopkinson GB, Bullen BR. Removable subcuticular skin suture in acute appendicitis: a prospective comparative clinical trial. *Br Med J (Clin Res Ed)*. 1982;284:869. doi:10.1136/bmj.284.6319.869
34. Vercelli S, Ferriero G, Sartorio F, Stissi V, Franchignoni F. How to assess postsurgical scars: a review of outcome measures. *Disabil Rehabil*. 2009;31:2055-2063. doi:10.3109/09638280902874196
35. Singer AJ, Church AL, Forrestal K, Werblud M, Valentine SM, Hollander JE. Comparison of patient satisfaction and practitioner satisfaction with wound appearance after traumatic wound repair. *Acad Emerg Med*. 1997;4:133-137. doi:10.1111/j.1553-2712.1997.tb03720.x
36. Aslam R, Khan SA, Ul Amir Z, Amir F. Interrupted versus continuous sutures for repair of episiotomy or 2n degree perineal tears. *J Ayub Med Coll Abbottabad*. 2015;27:680-683.
37. Kettle C, Dowswell T, Ismail KM. Continuous and interrupted suturing techniques for repair of episiotomy or second-degree tears. *Cochrane Database Syst Rev*. 2012;11:CD000947. doi:10.1002/14651858.CD000947.pub3
38. Gurusamy KS, Toon CD, Allen VB, Davidson BR. Continuous versus interrupted skin sutures for non-obstetric surgery. *Cochrane Database Syst Rev*. 2014;14(2):CD010365. doi:10.1002/14651858.CD010365.pub2
39. Sahlin S, Ahlberg J, Granstrom L, Ljungstrom KG. Monofilament versus multifilament absorbable sutures for abdominal closure. *Br J Surg*. 1993;80:322-324. doi:10.1002/bjs.1800800318
40. Majd A, Akbari A, Zloty D. Quantification of erythema associated with continuous versus interrupted nylon sutures in facial surgery repair: a randomized prospective study. *Dermatol Surg*. 2020;46:757-762. doi:10.1097/DSS.0000000000002145

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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