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Medical evidence assisting non-fatal strangulation prosecution: a scoping review

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ABSTRACT

Objectives Non-fatal strangulation (NFS) is a serious form of gendered violence that is fast becoming an offence in many jurisdictions worldwide. However, it often leaves little or no externally visible injuries making prosecution challenging. This review aimed to provide an overview of how health professionals can support the prosecution of criminal charges of NFS as part of regular practice, particularly when externally visible injuries are absent.

Method Eleven databases were searched with terms related to NFS and medical evidence in health sciences and legal databases. Eligible articles were English language and peer reviewed, published before 30 June 2021; sample over 18 years that had primarily survived a strangulation attempt and included medical investigations of NFS injuries, clinical documentation of NFS or medical evidence related to NFS prosecution.

Results Searches found 25 articles that were included for review. Alternate light sources appeared to be the most effective tool for finding evidence of intradermal injury among NFS survivors that were not otherwise visible. However, there was only one article that examined the utility of this tool. Other common diagnostic imaging was less effective at detection, but were sought after by prosecutors, particularly MRIs of the head and neck. Recording injuries and other aspects of the assault using standardised tools specific for NFS were suggested for documenting evidence. Other documentation included writing verbatim quotes of the experience of the assault and taking good quality photographs that could assist with corroborating a survivor's story and proving intent, if relevant for the jurisdiction.

Conclusion Clinical responses to NFS should include investigation and standardised documentation of internal and external injuries, subjective complaints and the experience of the assault. These records can assist in providing corroborating evidence of the assault, reducing the need for survivor testimony in court proceedings and increasing the likelihood of a guilty plea.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ First review of tools used to reveal and document non-fatal strangulation injuries in clinical settings for use in prosecution.
⇒ Identifies how health professionals can use various methods of recording to assist with the prosecution of non-fatal strangulation.
⇒ Does not provide a comprehensive systematic review given the variation in methods used to document strangulation.
⇒ Few studies have examined the usefulness of each of these documentation methods in legal settings.

INTRODUCTION

Strangulation is the partial or total restriction of the breath and/or blood vessels through pressure to the neck using ligatures or via manual strangulation (eg, hands, arms/chokehold), affecting, among other things, blood flow to the brain and oxygen delivery to the lungs.[1] Non-fatal strangulation (NFS) may cause a range of short-term and long-term physical and mental health issues including loss of or change in voice; difficulty in swallowing or breathing; physical injuries including bruising around the neck; petechial haemorrhages; injury to the brain resulting in unconsciousness, headaches, depression, anxiety and problems with memory and concentration; and has been associated with miscarriage and preterm births.[2–4]

Strangulation can easily be fatal and is a common feature of non-fatal violence against women.[5] Women are 13 times more likely than men to experience this type of assault[6] and prevalence among European and North American women is estimated to be 3%–9.7%[7] and between 27% and 68% among women who have experienced intimate partner violence.[8 9] Globally, NFS is becoming recognised as a serious form of violence, led by legislation in jurisdictions of the USA, specific offences of NFS have also been introduced in the UK, New Zealand, Canada and most of Australia.[10] In large part, this is due to a better understanding of the prevalence of strangulation as a form of domestic violence alongside its significant health consequences. Notably, NFS is a key marker for escalation of domestic violence with one study finding it raises the risk of becoming a victim of homicide or very

serious future harm by 7.48 times above victim–survivors who do not experience NFS.[8]

Several reviews have documented the prevalence and type of visible and psychological strangulation injuries.[11–13] However, there is a cumulative evidence that having few or no injuries visible to the naked eye is common following NFS.[2 11] The implications of this are not only problematic for healthcare, but can make the prosecution of NFS as a result of domestic violence more difficult. This is particularly true among jurisdictions that rely on evidence that the assault occurred beyond the testimony of the complainant and where this evidence can lend additional credibility to the complainant.[14]

Where NFS legislation is new or emerging, there has been recognition that reliable and consistent recording of the event, symptoms and injuries is needed for responders to strangulation, particularly where there are no obvious signs of injury.[15] Providing strong guidance for health workers for observing and recording injuries can be used in future for prosecution and it may be the only opportunity a patient has for thorough assessment and recording of NFS where domestic violence may prohibit future contact with the health system.[16] Because of the nature of health-service usage among victim–survivors of domestic violence, signs of strangulation may be encountered across a variety of healthcare settings, including consultations in forensic, emergency, reproductive health and general practice settings.

To our knowledge, no reviews have focused on whether and how health practitioners can best assist in the prosecution of NFS through routine consultation and assessment of patients reporting NFS. Therefore, the aim of this scoping review was to provide an overview of activities that can support clinical decision making and referral as well as the prosecution of criminal charges of NFS, particularly when externally visible injuries are absent. We refer to 'medical evidence' throughout this scoping review and we use this terminology to refer to evidence collected, documented and presented by health professionals in the context of a complaint of NFS.

In this scoping review, we provide an overview of available research to understand (1) what types of evidence can be routinely collected by medical practitioners when little or no externally visible evidence is observed in patients who have experienced NFS and (2) the types of medical documentation and evidence useful for prosecution of charges of NFS that can also contribute to healthcare. To get a broad understanding of the types of assessment available and how it might be used in court, the review was conducted in the following categories:

1. The types of assessment that reveal evidence of injury that is otherwise not externally visible to the naked eye from an incident of NFS.
2. The types of clinical documentation used to record an NFS incident.
3. The kind of medical evidence currently used to support the successful prosecution of charges of NFS.

METHOD

Search strategy

A literature search was conducted using PubMed, CINAHL, Cochrane, Embase, Medline, Scopus and Social Science Database to find publications from medical practice or health sciences related to NFS and medical imaging of injuries, and the documentation of strangulation. Law Journal Library, Westlaw, Lexis Advance and Worldlii were searched for Australia, the UK and the USA to find relevant publications on the kinds of medical evidence presented to courts in cases prosecuting NFS and analyses of 'what works' in that context. The search strategy was adapted to the requirements of each database and terms included "non-fatal strangulation", "choking", "strangulation", "garrotting" and "throttling", with searches of legal databases also including "medical" and "forensic evidence". See online supplemental material search strategies. Researchers and legal professionals in the field of NFS were contacted and reference lists in review articles examined for relevant articles not found in the searched databases.

Inclusion and exclusion criteria

To be included in the scoping review, we employed the following criteria relevant to all categories published before 30 June 2021:

1. Full-text English language articles.
2. Mean age of population is >18 years.
3. Peer reviewed, published articles.
4. Population that had primarily survived a strangulation attempt.
5. Medical investigation of NFS injuries, clinical documentation of NFS or medical evidence related to NFS prosecution.

Exclusion criteria relevant to all categories were:

1. Where strangulation in the population was primarily a suicide attempt (eg, via hanging).
2. Primarily reporting prevalence of NFS or associated injuries.

Separately, for medical assessment of NFS, articles were included where a clear method of injury investigation was reported, the method of investigation could reveal evidence of injury not visible to the naked eye, and the article was an original empirical study. Articles on medical assessment were further excluded from review if they included case studies with less than three people. Articles on documentation were included where tools were for clinical settings and focused on an NFS event, rather than broader domestic violence. Medical evidence related to prosecution included any article discussing NFS and medical evidence used in court or used to assist prosecution. Due to the dearth of articles available, review articles were included where they related to ways documentation can be done in clinical settings and medical evidence used in court.

Study selection

Following removal of duplicates, all articles were assessed by title and abstract by three reviewers using the selection criteria through Rayyan (rayyan.ai). Articles selected for full-text review were agreed on by all reviewers. All

articles selected for full-text review were read by the same reviewers. Inclusion to the study was agreed on by all reviewers with any disagreements settled by a fourth reviewer.

Charting and synthesis of data

All authors agreed on each article's focus and their respective categories. Charting tables were agreed on and trialled prior to conducting formal searches for this review, concentrating on recording and revealing injuries as would be the most likely focus for medical settings and that add credibility if a patient wishes to prosecute in future. They were further refined during the extraction process. Data were extracted by the lead author (LSS) from all articles by title, author and publication date. Data for medical investigation of NFS injuries were extracted focused on the type of study, sample size, method of investigation, referral, type of assessor, type of service, method of strangulation and injuries found/revealed. Documentation of injuries was extracted based on the article focus and type of documentation reported for NFS injuries. Medical evidence used in prosecution of NFS was extracted by article focus, jurisdiction, type of medical evidence used and any information regarding utility of evidence in court. Further information was extracted regarding expert testimony and is included in online supplemental material. Extracted data were organised into relevant thematic categories.

Patient and public involvement

This research involves analysis of existing research and involves no patients or members of the public.

RESULTS

The final searches retrieved a total of 3312 articles across 11 databases. Following removal of duplicates, review of abstracts and full-text screening of likely eligible articles, 26 were found to meet the inclusion criteria (see figure 1). However, two articles were found to draw on the same sample, so only the most recent version was included.[17 18] Thus, 25 articles were included in this review. Seven articles were related to medical assessment of injury from NFS, 8 articles for documentation of NFS and 12 articles regarding medical evidence in courts. Two articles were used in the review for both documentation of injuries and medical evidence in courts.[19 20]

Medical investigation

Study characteristics

Studies about medical imaging of NFS injury were composed of four retrospective analyses of medical data from hospitals or other medical facilities and three prospective analyses,[17 21 22] (see table 1). Four of the articles identified that survivors of NFS were referred for medical imaging as part of police investigation or by other protective organisations such as child/adult

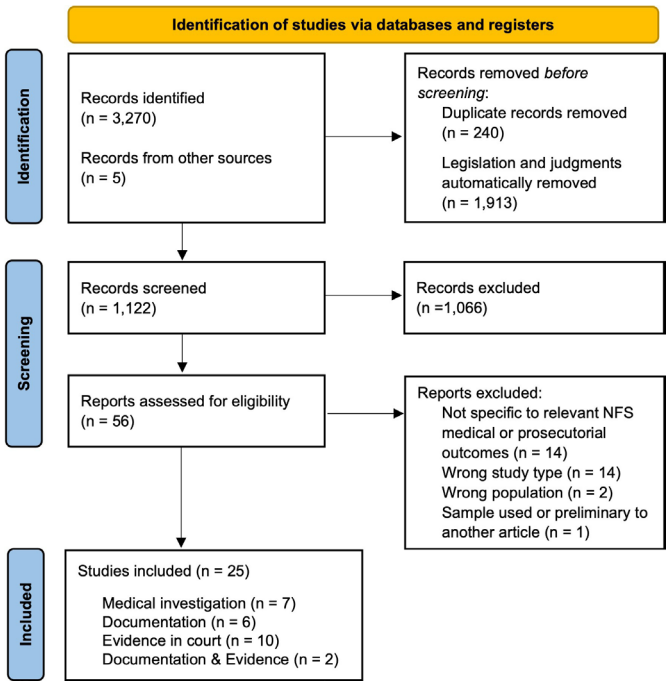

Figure 1 PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) flow diagram of screening.

protective services.[17 21–23] The remaining three articles did not specify a referral pathway.[24–26]

Presentations of NFS were evaluated in emergency departments, medical centres and by forensic medical examiners/nurses. Imaging investigations of physical injury and clinical symptoms were most frequently carried out by radiologists. One article involved assessment by forensic nurses.[23] Radiological imaging, including MRI and CT, was used in six studies. Of these, four studies used MRI,[17 21 22 25] and one study used CT or MRI.[26] Separately, one article did not use radiological imaging to investigate strangulation injuries, instead using alternative light sources (ALS).[23] See table 1 for details about these studies. Across all studies involving medical imaging, there were 959 cases of strangulation that were immediately non-fatal and where a person presented to medical personnel alive with a complaint of being strangled. Of these, 701 received some form of imaging.

The six studies that reported the methods of NFS showed that it was primarily manual, using one or two hands (79%), 11% used ligatures and 6% were chokeholds, the remainder used a combination of methods or the victim was unsure of the method.[17 21–24 26] Studies showed a gender disparity in strangulations where women were recorded as the primary victim–survivors in 87% (831) of cases. Where reported, it appeared that many of these strangulations were the result of assaults from intimate partners.[23]

While we do not report in detail externally visible or subjective complaints of injuries as they have been investigated in other reviews,[11] overall subjective complaints and clinical symptoms were frequent and varied across the studies. Only two studies reported the absence of

Table 1 Physical injuries recorded through clinical assessment

Author	Sample type	Total (Female)	No visible neck injuries	Neck swelling	Bruising/ haematoma	Abrasion	Petechiae	Ligature mark	Subconjunctival haemorrhage	Erythema	Neck tenderness
Bruguier *et al*[25]	Retrospective review of clinical examination of strangulation survivors presenting to hospital 2009–2013	112 (93)	28	n/s	84	n/s	8	n/s	n/s	n/s	n/s
Christie *et al*[17]	Prospective analysis of survivors of manual strangulation referred by police for forensic examination	56 (35)	n/s	5	35	31	8	2	n/s	35	n/s
Heimer *et al*[22]	Prospective analysis of survivors of manual strangulation referred by police for forensic examination	114 (90)	80	0	72	38	4	n/s	n/s	n/s	n/s
Holbrook and Jackson[23]	Retrospective review of patients with a history of manual strangulation referred by Police 2008–2011	172 (171)	159	n/s	n/s	n/s	35	n/s	n/s	n/s	n/s
Matusz *et al*[26]	Retrospective analysis of Emergency room presentations of strangulation or near hanging	349 (314)	60	21	155	n/s	19	8	15	n/s	63/134* posterior/ anterior
Yen *et al*[21]	Prospective analysis of strangulation survivors evaluated by a forensic pathologist and referred by local police	14 (12)	n/s	n/s	10	n/s	4	n/s	n/s	n/s	6
Zuberi *et al*[24]	Retrospective review of strangulation survivors presenting to an emergency department and receiving a CT 2009–2016	142 (116)	n/s	3	73	n/s	7	n/s	n/s	n/s	47
	Injury sum		327	29	429	69	85	10	15	35	187
	Total N for those with data		747	547	787	282	959	405	349	56	505
	% from recorded assessments		44%	5%	55%	24%	9%	2%	4%	63%	37%

*Highest number recorded for cell used in calculation.
n/s, not significant.

subjective complaints showing that 17% of those 463 survivors reported no subjective symptoms following NFS.[22 26] Thus, the majority (83%) of strangulation survivors had some reported symptoms including neck pain, loss of consciousness and difficulty swallowing. On the other hand, absence of external injuries ranged from 17% to 93%, with the average being 44% of NFS survivors with no externally visible evidence of external injury. One of these studies reported 17% of NFS presentations as having neither subjective complaints nor physically visible symptoms.[26]

The most common injury reported across studies was bruising/haematoma related to the neck or face. Where injuries were recorded in two or more studies, on average the following injuries were present: neck redness/bruising 55%; abrasions 41%; neck tenderness 37%; petechiae 9% found on the neck, but also found in the eyes, on the gumline and behind the ears[17 23 27]; swelling 5%; subconjunctival haemorrhage 4%; and ligature marks 2%. Table 1 records the number of visible physical injuries and subjective complaints recorded through routine clinical assessment across the included studies.

Imaging

Survivors who received CT scans showed visible injuries in 77% of cases. However, only 8% of all cases examined found evidence of injury.[24 26] CT of the neck generally did not provide further information than usual clinical investigation related to injury visibility (see table 2). Comparatively, MRI of the neck and/or head found relevant injuries of the assault in at least 52% of the NFS cases examined (see table 2). MRI was at times able to detect injuries when no corresponding external injury was visible.[21 22] One study found 39% of cases with evidence of injury in the absence of other significant clinical findings through MRI.[22] Although MRI was able to find internal injuries in approximately half of the cases examined across all studies, there was no clear pattern of symptoms that were related to radiological findings outside of neck pain, which was a common subjective complaint across these imaging studies.

Only one study used imaging other than radiological investigation using an ALS. An ALS emits ultraviolent, visible and infrared wavelengths through a powerful lamp enhancing the visibility of some evidence.[23] This study showed ALS detected evidence of intradermal injury in 98% of strangulation survivors that had no externally visible injuries in clinical examination. This imaging was able to be produced by forensic nurses and showed the sensitivity to detect patterns in some injuries, for example, a shoe print. Injuries revealed through ALS were able to be photographed.

Documentation of NFS

Study characteristics

All eight articles that discussed clinical documentation and disclosure of NFS were focused on clinical care (see online supplemental table 1). The majority of articles were reviews focused on clinical practice care and evaluation of patients. However, two involved retrospective analysis of the mechanisms and prevalence of injuries (including subjective) found during medicolegal examination.[27 28] One article also included case presentation examples of the tool being used.[20] All articles were relatively consistent in their general recommendations and approaches to documenting evidence. Overall, they provided a comprehensive strategy for evaluating NFS injuries and symptoms and most were conscious of the utility of this documentation for evidence for prosecution of criminal charges of NFS.

Documentation tools

The use of available documentation tools such as those created by Faugno *et al*[20] and the Training Institute on Strangulation Prevention were primary strategies for recording information about NFS.[19 28 29] These documentation tools were specialised for physical examination providing a body map to indicate injuries, a checklist for physical examination and injuries of concern, and providing a thorough record of strangulation history including details of the strangulation incident. Thorough questioning regarding strangulation history was recommended by all articles alongside some specific recommendations regarding quoting victim–survivors' verbatim accounts of the incident, and recording their demeanour and emotional/mental status.[2 19 20] Taking this type of documentation was claimed to greatly assist appropriate health and legal intervention.

Questions and quotations

As NFS injuries may be minimal or absent, providing clear documentation of the survivor's experience of the strangulation event was discussed as supportive of the prosecution of an NFS offence. Questions that could be asked by health professionals might include 'What were they saying to you as you were strangled?' and 'What did you think was going to happen?'.[2 3 20] It was observed that, where possible, answers to questions posed by health professionals should be recorded in quotation marks to assist with communicating observations to prosecution services and provide corroboration for survivors' statements of events to police and others, including social workers.[2 20] Although quotations are unlikely to assist with further clinical assessment, they were described as important for prosecutors in preparing the brief of evidence to support the prosecution, particularly where physical evidence is absent or minimal. For example, direct quotations from the victim–survivor can be useful in discrediting claims made by an accused person that the complainant consented to the NFS or that the accused was acting in self-defence and generally bolster the complainant's credibility about the circumstances of the offending, particularly where there are other documented injuries consistent with their account of the incident.[2]

Table 2 Advanced techniques for assessment of strangulation injuries

Author	Assessment type and no assessed	Visible neck injury	Injuries found	Time delay	Findings correlated with	Injuries found	Usefulness of examination
Bruguier *et al*[25]	Neck MRI, 11	n/s	5	Median 24 hours Range 3–336 hours	Neck pain, vision changes, Dysphagia	Blood serum level in the glottis space, haemorrhage of the vocal cord, haemorrhage in the platysma muscle, haemorrhage in the sternocleidomastoid muscle, superior jugulocarotid ganglion haemorrhage subcutaneous tissue haemorrhage	Injuries detected in 45% of cases examined with MRI. Efficient for diagnosing soft tissue injury
Christe *et al*[17]	Neck MRI, 52	n/s	31+	Median 38 hours Mean 50 hours Range 3–300 hours	Petechial haemorrhage loss of consciousness haematoma	31 (55%) subcutaneous haemorrhage 16 (29%) intramuscular haemorrhage and bleeding	Injuries detected in at least 55% of cases examined with MRI. Efficient for diagnosing soft tissue injury
Heimer *et al*[22]	Head and Neck MRI, 114	77% (88)	49	Mean 48.3 hours No sig difference between positive and negative cases in time to MRI	Chokeholds were associated with few external findings and laryngeal MRI findings. 26/106 showed corresponding external and MRI results.	5 Platysma thickening 13 lymph node haemorrhage 21 cervical soft tissue injury (6 superficial) 1 vessel-nerve sheath 1 laryngeal fracture 14 perilaryngeal 1 localised oedema (brain)	Injuries were detected in 45% of cases examined with MRI. MRI was unable to estimate severity of strangulation, but did detect injuries where none were externally visible in 10 cases. The clinical radiologist found significantly less injuries than the forensic radiologist, which may indicate the utility for forensic specialists to examine strangulation injuries for court cases.
Holbrook and Jackson[23]	Alternative light sources, 159	0	153	n/s	At least two of the following: dizziness, visual changes, loss of consciousness, headache, tinnitus, coughing, nausea/ vomiting, incontinence, petechiae, muscle spasms, memory loss, shortness of breath and (near) syncope.	153 (98%) showed intradermal injuries	Injuries detected in 98% of cases without externally visible injury. High level of sensitivity in displaying invisible injury capable of showing patterned bruising (such as shoe prints) that can be photographed. Cost effective and efficient. Can be done by nurses.
Matusz *et al*[26]	Head, Neck & Cervical spine CT* or Neck MRI, 209 (9 MRI)	(95%) 197	6	297 (85%) had documented medical follow-up, and none of these had a new diagnosis of serious injury or stroke.	Manual strangulation (3): neck pain, dysphagia hanging (1): abnormal Glasgow Coma Scale, neck swelling, tenderness	1 laryngeal swelling (CT) 2 cervical artery dissections 1 probable thyroid contusion 2 subdural haematomas (both subdural haematomas were deemed very unlikely to be due to strangulation.)	Injuries were detected in only 3% of cases that were examined radiologically. While both CT and MRI were used, CT was used in only 96% of cases. Therefore, CT appears to have a low sensitivity to find injuries.

Continued

Table 2 Continued

Author	Assessment type and no assessed	Visible neck injury	Injuries found	Time delay	Findings correlated with	Injuries found	Usefulness of examination
Yen *et al*[21]	MRI, 14	n/s	14	Median 20.5 hours Mean 44.7 hours Traumatic inner findings were visible by MRI for at least 3 days after the incident; in one case, injury was seen even 12 days after the act.	The haemorrhages in the muscles, lymph nodes, or deep neck structures barely correlated with externally visible injuries, with localised pain in the area and no external signs of injury indicative of haemorrhage for 3.	9 subcutaneous haemorrhages 10 intramuscular haemorrhages 10 lymph node haemorrhages 4 haemorrhages of salivary glands 2 laryngeal oedemas 3 soft part bleeding in the larynx 2 intracutaneous haemorrhages	All cases showed radiological evidence of injury and 79% of those were of high confidence. Detection showed high sensitivity among this cohort with efficiency in diagnosing soft tissue injuries.
Zuberi *et al*[24]	CT, 142	73+	16	n/s	Redness/bruising of the neck, neck tenderness	16 soft tissue subcutaneous haemorrhages 3 vascular injuries	Low sensitivity in finding injury. More efficient at detection of bone and cartilaginous lesions, which are not often present in strangulation

*CT was the primary method of investigation.
n/s, not stated.

Photographs

Some studies advocated that photographs should be taken where there are external injuries present and visible.[20 29 30] Funk and Schuppel[29] recommended four types of photographs: (1) a distance photograph that shows the person's full body to identify them and the location of any injuries; (2) close up photographs of injuries from different angles and with each angle taken both with and without a ruler placed by the injury; (3) follow-up photographs of injuries across different time intervals to show them as they change over time and to document if any new injuries appear that may not have been present immediately after the event and finally (4) it was recommended to take a photograph of the survivor demonstrating how they were strangled. Patients can be asked how the strangulation took place, with one or two hands, forearm, or the use of a ligature etc, which arm/hand/what kind of ligature, or use a mannequin[30] to assist with demonstration and documentation.

Medical evidence in court

Study characteristics

Twelve articles were found to meet our criteria for medical evidence related to the prosecution of NFS (see online supplemental table 2). Five of these were reviews, with two focused on prosecution,[19 31] one broadly reviewed medical and legal research on NFS,[12] one focused on forensic pathology and medicolegal investigations[32] and one focused on best practice for healthcare providers.[20] Five articles were focused on providing recommendations and strategies for prosecuting NFS.[33–37] Lastly, two articles were retrospective analyses of case criminal legal issues and adjudication decisions of NFS.[38 39] All articles primarily reviewed studies and cases from the USA, with the exception of four articles that focused on evidence from Australasia, Canada and the UK.[31 32 37 40]

The value of evidence

It was apparent that medical professionals' recording of strangulation symptoms, injuries and statements were vital to evidence gathering for prosecution across all articles. Evidence that was recommended as useful for prosecutors were any diagnostic testing; photographic images and medical records of any visible injuries such as contusions, scratches, ligature marks or defensive wounds related to the assault; and records of other clinical symptoms related to the assault, neck pain, loss of consciousness or incontinence.[12 19 20 35 38 39] Strack *et al*[39] described the significance of medical observations as more 'robust' for prosecution evidence gathering than the same observations recorded by law enforcement.

Importantly, a lack of external injury was discussed across all articles, with three remarking that arguments that absence of injury are consistent with the occurrence of strangulation is ambiguous,[37] or potentially misleading[31 32] to the court. That is, although absence of external injury may be consistent with strangulation, it is also consistent with not experiencing NFS. On the other

hand, the use of coordinated evidence collection using questioning provided broader corroborating evidence that did not rely solely on the presence of external injury.[12 38] The overall quality of medical evidence was discussed as a central factor in prosecuting NFS cases.[12] This was reiterated by data finding that cases were 40% more likely to be filed when NFS victim–survivors were examined using procedural collection of evidence through forensic nurses, compared with cases where a forensic examination did not take place.[36]

DISCUSSION

This scoping review aimed to provide an overview of whether and how health professionals can support the prosecution of criminal charges of NFS through routine practice, particularly when injuries are not visible to the naked eye. Overall, it was clear that medical professionals have a range of investigative tools with differing sensitivity available to reveal and record evidence of NFS and assist clinical investigation. Although many victim–survivors may not wish to proceed with a prosecution when they initially present in a healthcare setting, victim–survivors may choose to proceed at some future time. Ensuring that NFS is well-documented empowers victim–survivors to make the choice to proceed. A lack of documentation, on the other hand, may limit opportunities for potential future legal pathways. Importantly, victim–survivors' decision-making processes are not always linear and can be influenced by their own changing circumstances as well as system-related factors such as delay and or available support.[41] The use of these tools in clinical settings was considered important to progress the prosecution of NFS offences across jurisdictions providing evaluations over and above those provided by police.[36 39] Our review revealed the following techniques that can be built-in into regular practice that can assist with clinical and judicial outcomes:

1. Standardised documentation procedure using clinical charts such as those developed by the Strangulation Training Institute.
2. Photographs of patient injuries and follow-up if new injuries develop, taking into consideration lighting and patient skin tone.
3. Referral for appropriate imaging to reveal signs of injury not visible to the naked eye that may be clinically relevant.

Revealing injuries

Despite CT as the recommended pathway for the detection of vascular injuries, few studies reported on the results of CT in the context of strangulation[42] and its ability to reveal injuries compared with MRI were limited among the included articles. It is possible that because MRI provides superior detection of soft tissue and ligamentous injuries in the context of strangulation, fewer studies utilised CT in their investigations.[43 44] However, importantly in everyday contexts MRI can be costly and difficult to access with medical limitations to it being performed, including the obstruction of metal objects in a person (eg, piercings, medical devices), inability to have an MRI with contrast, confined space anxiety that may be particularly relevant to this patient group and weight/size limitations. Thus, CT continues to be an appropriate pathway if there are clinical indications for imaging.

The use of ALS appeared to be the most consistent for revealing injuries that were otherwise invisible to the naked eye, though only one study investigated this method.[23] If further investigations of this method support its effectiveness at revealing injuries, use of ALS is likely to be resource, time and cost-efficient, and able to provide indications for further assessment, including diagnostic imaging. Critically, ALS could be more likely to find evidence of intradermal injury not visible under normal light that can then be photographed, with no differences in injury detection dependent on age or skin tone that are otherwise susceptible to bias in photography under normal light.[20 23 45] Unfortunately, there have been no studies that have explored the use of ALS in the prosecution of NFS offences and its utility may be more likely in forensic settings than broader clinical contexts. However, the use of ALS to document injuries is likely to provide important evidence in a criminal trial of NFS.

Documenting injuries

Taking a patient's history of events should be done using standardised documentation tools specialised for strangulation, with priority placed on reciting the patient's exact words in response to questions. Recording quotations will provide documentation that can assist in proving the alleged offender's intent to hinder the victim's breath or blood flow, that is relevant in some jurisdictions.[10] As many victim–survivors report fear that they felt they were going to die and often report death threats,[34 38 39] asking questions about what survivors were thinking during the assault and what the perpetrator may have said or threatened could be important evidence. Several documentation tools have been developed, particularly in the USA[19] and Canada,[46] with the most up to date and developed of these created by the Training Institute on Strangulation Prevention (www.strangulationtraininginstitute.com). Using standardised documentation tools in measuring and recording injuries should produce evidence that is of better quality for criminal trials[45] and greater confidence in detecting signs and symptoms of injuries in health settings that does not rely on individual practitioner knowledge. Further, this documentation may alleviate some patient experiences where they report difficulty accessing health workers who understand the potential severity of NFS and receiving referrals for scans or social work support.[47]

Clinical evaluation may be difficult if a survivor has any memory problems or if there is little physical evidence of strangulation and it may take several hours for serious internal injuries to be found.[19] Because of the potential delay in the presentation of injuries, patients may need

to be admitted for observation for 24–36 hours and to monitor for signs that may lead to delayed death.[48] Information such as whether the patient lost consciousness or whether they lost control of their bladder and/or bowels will provide vital clinical indicators of NFS and can also be important evidence for a criminal trial. Importantly, if there are memory problems present, a survivor's inability to recall specific events when evaluated may produce a deceivingly low number of clinical symptoms.[27] If memory problems are noted, it is important to remember that evidence of memory difficulties are not inconsistent with an NFS assault.[9 12 27]

Identification of injuries may present further challenges where a person has a darker skin tone where injuries such as bruising may not be as visible.[20] While we do not know the specific implications that skin tone may have on identification of strangulation injuries, it is vital to consider this when making assessments of people with darker complexions, and the utility of ALS if it is available to assist with the visibility of those injuries. Regardless of access to ALS, any visible injuries should be photographed using a camera with high resolution and good lighting to increase the likelihood that injuries will be captured.[39]

The utility of medical evidence for prosecution

Overall, evidence gathering as part of routine medical assessment of NFS can lead to increased numbers of prosecutions of NFS and a higher likelihood of successful prosecution.[36] Corroborative medical evidence of NFS can rebut the accused's claim that the NFS was carried out by accident or in self-defence. Furthermore, studies have identified that for survivors who have experienced trauma, giving evidence in court proceedings can be experienced as a form of secondary victimisation as they must relive the experience all over again in a context where their version of events is challenged.[49] The more corroborative evidence available to the prosecution the more likely the accused is to plead guilty, avoiding the need for the survivor to testify. Furthermore, for a range of reasons, it is common for survivors of NFS and other family violence related offences to withdraw their support for prosecution.[14] The presence of other forms of evidence, beyond the testimony of the complainant/survivor, may result in some NFS prosecutions proceeding despite the absence of the complainant/survivor's testimony.[50] In the context of rape jury trials, research suggests that some jury members expect to see medical or scientific evidence in the course of the trial,[51] though there is currently no research about this issue regarding NFS jury trials.

Risks of bias

While this research presents a scoping review and does not include a risk of bias, there were nonetheless clear avenues for introduction of bias. First, the evidence for medical imaging largely involved studies with retrospective review of NFS cases presenting in medical settings. Unlike prospective studies, these studies were uncontrolled and were, therefore, less likely to have any consistent protocols for assessing and documenting injuries from strangulation and for whether a person was eligible for imaging, excluding that of Bruguier *et al*.[25] This may have resulted in more cases where injuries were already visible receiving imaging and inflating the number of NFS injuries identified through MRI or CT scans.[22 26] Further, exercise of discretion for referral was identified as a problem even when decision guidelines were in place regarding imaging. For example, Bruguier *et al* showed that despite MRI eligibility criteria for NFS symptoms and injuries, only 11 of the 112 survivors over a 4-year period received an MRI following clinical assessment. These referral biases, particularly in retrospective studies, may lead to an inflated claim of the effectiveness of MRI in detecting of NFS injuries, particularly among those who have no externally visible symptoms. Future research in examining internal injuries from NFS should focus on prospective reviews of NFS investigation, particularly where evidence is limited, but promising, such as for ALS.

Strengths and limitations

Aside from biases, a considerable limitation of this review was the lack of available literature reviewing CT scans for strangulation injuries. Despite CT angiography the current 'gold standard'[42] for detecting vascular injuries, there were a surprising lack of articles available for review in this area. This may have been due to language restrictions used in this review that may have excluded relevant research conducted and published in other languages. Notably, several titles and abstracts able to be screened in English from Russian articles, may have been relevant to this review. Future reviews should, therefore, consider including Russian, among other, language articles if possible.

Another limitation of the available evidence was the primarily qualitative assessments from authors as experienced clinicians and prosecutors describing the utility of documentation tools in court cases, the use of direct quotations in notes, and the importance of photographs taken by health professionals in underpinning prosecutions of NFS.[19] More research is needed in this area to confirm the most robust clinical documentation tool that assists with both the care of the patient and, separately, their utility as evidence in the prosecution of NFS. It is possible that further research on documentation tools efficacy in prosecution and further detail on investigation of internal injuries from NFS are available in other languages that were not able to be assessed within the bounds of this scoping review. Despite these limitations, this review provides a first and comprehensive review of the literature to guide clinicians regarding clinical decision making, referral and criminal prosecution of NFS, when the victim–survivor wishes to take that path.

CONCLUSION

Medical personnel will often be the first point of disclosure for NFS by victim–survivors of domestic violence[52] and are otherwise often referred by police for medical attention in the aftermath of NFS. Therefore, it is essential that

medical responses to NFS include consistent investigation and documentation of internal injuries, the experience of the assault, and the signs and symptoms resulting from NFS. These records can assist with clinical referrals,[45] and provide additional corroborating evidence of the assault supporting victim–survivors who choose to engage with legal pathways in the future.

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Search Strategies

Database	Search Terms	Other Filtering
Scopus	(TITLE ("Strangulation" OR "Strangle" OR "Garrotte" OR "Constrict the neck" OR "neck constriction")) AND (TITLE-ABS ("Evidence" OR "forensic" OR "symptoms" OR "medical" OR "injuries" OR "harm")) AND (TITLE-ABS-KEY ("Neck" OR "throat"))	
Social Sciences Database	Manual Nonfatal Strangulation Assessment OR (non fatal strangulation AND assessment AND NOT homicide)	
Medline	TI ("Strangulation" OR "Strangle" OR "Garrotte" OR "Constrict the neck" OR "neck constriction") AND TI ("Evidence" OR "forensic" OR "symptoms" OR "medical" OR "injuries" OR "harm")	
CINAHL	TI ("Strangulation" OR "Strangle" OR "Garrotte" OR "Constrict the neck" OR "neck constriction") AND TI ("Evidence" OR "forensic" OR "symptoms" OR "medical" OR "injuries" OR "harm")	
EMBASE	('strangulation':ti OR 'strangle':ti OR 'garrotte':ti OR 'choke':ti OR 'choking':ti OR 'constrict the neck':ti OR 'neck constriction':ti) AND ('evidence':ab,ti OR 'forensic':ab,ti OR 'symptoms':ab,ti OR 'medical':ab,ti OR 'injuries':ab,ti OR 'harm':ab,ti) NOT ('penile':ab,ti OR 'bowel':ab,ti OR 'hernia':ab,ti OR 'children':ab,ti OR 'pediatric':ab,ti) AND [<1966-2021]/py	
PubMed	((((("Strangulation"[Title/Abstract] OR "Strangle"[Title/Abstract] OR "Garrotte"[Title/Abstract] OR "neck constriction"[Title/Abstract] OR "Choke"[Title/Abstract] OR "choking"[Title/Abstract]) AND ("Evidence"[Title] OR "forensic"[Title] OR "symptoms"[Title] OR "medical"[Title] OR "injuries"[Title] OR "harm"[Title]) AND "english"[Language]) NOT ("children"[All Fields] OR "infant"[All Fields] OR "penile"[All Fields] OR "bowel"[All Fields])) AND "english"[Language]) AND ((1000/1/1:2021/6/30[pdat]) AND (english[Filter]))	
Cochrane	("Strangulation" OR "Strangle" OR "Garrotte" OR "Constrict the neck" OR "neck constriction" OR "choke" OR "choking"):ti,ab,kw AND ("Evidence" OR "forensic" OR	

	"symptoms" OR "medical" OR "injuries" OR "harm"):ti,ab,kw NOT ("Children" OR "infants" OR "bowel" OR "hernia"):ti,ab,kw	
Westlaw AU	non-fatal strangulation OR throttling OR strangulation OR choking	Secondary Sources : Law Reviews and Journals
Westlaw Classic	non-fatal strangulation OR throttling OR garrotting OR strangulation OR choking	Secondary Sources : Law Reviews & Journals
Westlaw UK	non-fatal strangulation OR throttling OR garrotting OR strangulation OR choking	Journals
Lexis AU	non-fatal strangulation OR garrotting OR strangulation OR choking	Secondary materials : Journals
Lexis UK	non-fatal strangulation OR garrotting OR strangulation OR choking	Secondary materials
Lexis US	(non-fatal strangulation AND medical) or (non fatal strangulation AND forensic evidence)	Secondary materials
Law Journal Library	(non-fatal strangulation, AND NOT homicide)	Articles and review
Worldlii	non-fatal strangulation AND medical	

Expert testimony

In the US, medical testimony has been used to shed light on the specifics of injury present in the case.[1–4] Expert witness testimony in the United States has been provided by coroners, medical examiners, physicians, paramedics, and forensic nurses. However, across the articles it was clear that expert testimony is not always sought in prosecutions of NFS. In Canada, prior to the introduction of a specific NFS law, a review of over 100 cases involving charges of non-homicidal domestic violence strangulation between 2005 and 2011 found that medical experts rarely testified.[5] Of these, only three cases referenced an expert witness discussing the signs, symptoms, risks, and/or injuries of NFS. It is unknown from this research whether the presence of expert medical witnesses impacted the findings of the cases. However, Busby[5] observes that expert evidence is necessary where knowledge is likely to be outside of the experience of judge or jury.

On the other hand, expert testimony was discussed and often provided in the US, where specific NFS legislation is commonplace across the country.[1,4,6,7] In trials, medical testimony was utilised primarily when the court and jury required education about strangulation and its inherent lethality. Further, expert testimony was described as valuable for explaining why injuries may not have been visible or documented following an assault, as well as the significance of the facts of the case.[1,6] Several articles specifically recommended forensic nurses as ideal expert witnesses because of their medical background, their experience evaluating signs and symptoms of strangulation, and experience documenting and photographing evidence.[1,2,7,8]

Overall, while expert testimony was not always utilised, it was evident that medical professionals' recording of strangulation symptoms, injuries, and statements were vital to evidence gathering for prosecution.[6] These records were viewed as important, particularly in

circumstances where externally visible injuries were not present and were helpful in buttressing survivors' accounts.[3,6,9]

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Supplementary Table 1. Documentation of non-fatal strangulation in clinical settings

Author	Jurisdiction	Article Type	Article focus	Type of documentation recommended
Armstrong & Strack, 2016	US	Review	Review of strangulation care in medical settings	• Strangulation documentation tool from the training institute on strangulation prevention
Faugno et al., 2013	US	Case studies and review	Strangulation forensic exam for health care	• Use of body map drawings identifying the shape & colour of injuries, • Subjective findings (e.g., nausea), • Photographs of injuries, • Measurements of injuries, • Verbatim account of the assault from the patient, • Patient demeanour, • emotional/mental status of patient, • Bowel movements or urine loss during assault, • Strangulation documentation tool example provided.
Foley, 2015	US	Review	Health and nurses	• Nurse screening using the Canadian strangulation protocol tool - 6 brief questions for documentation
Funk & Schuppel, 2003	US	Case study and review	Clinical treatment	• Photographs of injuries close-up, far away, demonstrating how they were strangled, and follow up photos of injuries. • Strangulation documentation tool from the training institute on strangulation prevention.
Jordan et al., 2020	US	Case study and review	Clinical treatment	• Body mapping of injuries • Photographs of injuries (and potentially use of alternative light source or illumacam) • Demonstrations of event • If in a forensic setting: collection of specimens from face, head, neck, mouth and fingernails
Marks et al., 2020	US	Retrospective cohort study	Social work intervention for DV related NFS	• Strangulation documentation tool from the training institute on strangulation prevention

Author	Jurisdiction	Article Type	Article focus	Type of documentation recommended
McClane et al., 2001	US	Review	Review of strangulation care in medical settings	• Emotional/mental status of patient, • Patients account of the assault • How they were strangled (e.g., one hand, position they were in) • Questions about assailant ("what did they say to you as you were being strangled") with answers recorded verbatim
Shields et al., 2010	US	Retrospective analysis	retrospective clinical	• The method of strangulation, • The lapse of time between the event and the examination, • Physical and subjective symptoms experienced by the victim

Supplementary Table 2. Medical evidence for use in prosecution of non-fatal strangulation

Author	Jurisdiction	Article focus	Relevant conclusions
Armstrong & Strack, 2016	US	Review of investigation and prosecution of NFS	Recommend using MRI as it is sensitive to document deep injuries not visible during physical exam and this evidence would be important in a criminal trial. However, all documentation of external and internal injury was referenced as critical to criminal prosecution of NFS
Busby, 2012	Canada	Review of Canadian prosecutions	Expert testimony in Canada before legislation was introduced showed medical experts rarely testified in NFS cases.
Cloud, 2019	US	Prosecuting strategies for NFS	Use of paramedics and forensic nurses should be used to investigate injury that may be invisible and provide medical treatment. Forensic nurses should be used to testify as medical experts about the seriousness of strangulation and provide detail regarding injuries.
Duflou, 2020	Australia/ Australasia	Review of general progress of forensic pathology and medico-legal investigations	Determining that the absence of NFS injuries as consistent with strangulation can mislead the court.
Edwards, 2015	US	Case reviews of strangulation risk and court understanding	The misleading aspect of the lack of injury in strangulation cases as stated by expert witness.
Faugno et al., 2013	US	Review of strangulation forensic exams for health care	Describes the role of forensic nurses in examination and documentation of patients and communicating those findings to law enforcement. Includes case example.
Prior, 2018	US, San Diego	Factors improving strangulation prosecution	Discusses the testimony of medical professionals and use of forensic examinations via nurses for strangulations. Found that since the program began cases were 40% more likely to be filed than without forensic exams.
Pritchard et al., 2017	US	Review of research on NFS	Discusses the quality of medical evidence as a central factor in prosecuting strangulation cases, where for some jurisdictions providing evidence of serious bodily injury is important. A need to provide good evidence of as NFS injuries are usually mostly internal. Provides discussion on the utility of coordinated evidence collection to aid prosecutors and reduce reliance on victim testimony.
Reckdenwald et al., 2020	US, Breward County	Study examining prosecutorial responses to NFS over 3 years	Examines whether the victim sought medical attention and if photos were taken of injuries were considered possible evidence to be used for prosecution - 67% of cases mentioned medical attention was sought to examine and document injuries. 91.4% had photographs.

Author	Jurisdiction	Article focus	Relevant conclusions
			47% of recognised NFS cases were formally charged. However, those that were charged found 93% of cases resulted in a guilty plea, with 52% of those for a lesser charge/misdemeanour. Using medical professionals as well as forensic medical documentation to provide additional documentation of evidence for signs and symptoms of strangulation strengthen the ability to prosecute. Having medical experts testify alongside good evidence removes the onus on the victim to prove the events happened.
Strack et al., 2001	US	Retrospective case review of crimes and legal issues	Prosecution generally occurred when there was evidence of injuries from other forms of violence, independent corroboration of being strangled, and a prior history of DV. 25% of cases were rejected for prosecution when there was little corroboration of the strangulation or uncertainty of the 'primary aggressor'. 35% of victims had injuries too minor to photograph. Only 5% of victims sought medical attention within 48 hours of the assault. When medical treatment occurred, the observations were robust with critical differences in language not found in police reporting and were significant for prosecution.
Strack & Gwinn., 2011	US	Recommendations for changes to prosecution of NFS	Recommendations included using doctors and forensic nurses as experts to testify in court about strangulation, and using expert witnesses to teach jurors about medical, technical, or scientific principles or expressing their opinion on the facts of the case. Primarily, medical examiners, emergency room physicians, forensic nurses, or paramedics with training and experience handling strangulation were suggested as the best consideration for witnesses. Forensic nurses especially were found to be good witnesses because of their medical background and experience evaluating and documenting evidence.
Strack et al., 2020	US	Successful Investigation and prosecution of NFS	Using forensic investigators and nurses to gather evidence and photographs were suggested and concluded that this should dramatically increase felony filings and convictions. Medical examination is one of the best methods of collecting evidence for prosecutions and these could include the use of high definition cameras and alternative light sources if properly trained.