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REVIEW ARTICLE/BRIEF REVIEW

Review article: Perioperative checklist methodologies
Article de synthèse: La méthodologie des listes de contrôle périopératoires

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Abstract

Purpose *Checklists are increasingly being used by surgical teams in the perioperative period to improve clinical care and increase patient safety. In this article, we review some of the mechanisms by which checklists work and evaluate evidence supporting their use.*

Principal findings *There is a growing body of evidence showing the importance of team-based checklists in clinical care. In multiple complex clinical environments, from the operating room to the intensive care unit, checklists can help ensure adherence to known standards of care and improve communication amongst team members. In addition, the efficacy of checklists is being shown in both developed and developing settings.*

Conclusion *Checklists can aid clinicians involved in complex processes and multidisciplinary team interactions to improve the quality and safety of care by prompting dialogue and exchange of information.*

Résumé

Objectif *Les listes de contrôle sont de plus en plus utilisées par les équipes chirurgicales en période périopératoire afin d'améliorer les soins cliniques et d'augmenter la sécurité des patients. Dans cet article, nous passons en revue certains des mécanismes qui garantissent le bon fonctionnement des listes de contrôle et évaluons les données probantes soutenant leur utilisation.*

Constatations principales *Il existe un corpus croissant de données probantes démontrant l'importance des listes de contrôle centrées sur l'équipe dans les soins cliniques. Dans de nombreux environnements cliniques complexes allant de la salle d'opération à l'unité des soins intensifs, les listes de contrôle peuvent aider à garantir le respect des normes connues de soins et améliorer la communication entre les membres d'une équipe. En outre, l'efficacité des listes de contrôle est démontrée aussi bien dans des pays développés que dans des pays en voie de développement.*

Conclusion *Les listes de contrôle peuvent aider les cliniciens travaillant dans des processus complexes et favoriser les interactions au sein d'équipes pluridisciplinaires afin d'améliorer la qualité et la sécurité des soins en promouvant le dialogue et l'échange d'informations.*

When boarding an airplane, we are reassured to see the flight crew use a checklist, but doctors have not typically considered the use of team-based checklists during medical care as a comfort for patients or as inspiring confidence in their abilities and clinical judgement. A checklist is a reminder of items required, things to be done, or issues to be considered; more importantly, it is also a tool to enhance and structure communication. A checklist takes several forms, the simplest being a shopping list or a list of tasks to complete. While nurses have long used checklists as a structured component of clinical care, particularly in the perioperative period to prepare patients for surgery, the concept has come late to physicians. It seems too banal to be used for a function as complex and important as medical care where the task of ensuring quality cutting-edge therapy is in the hands of some of the best-educated highly trained professionals in the world. Yet, the complexity of

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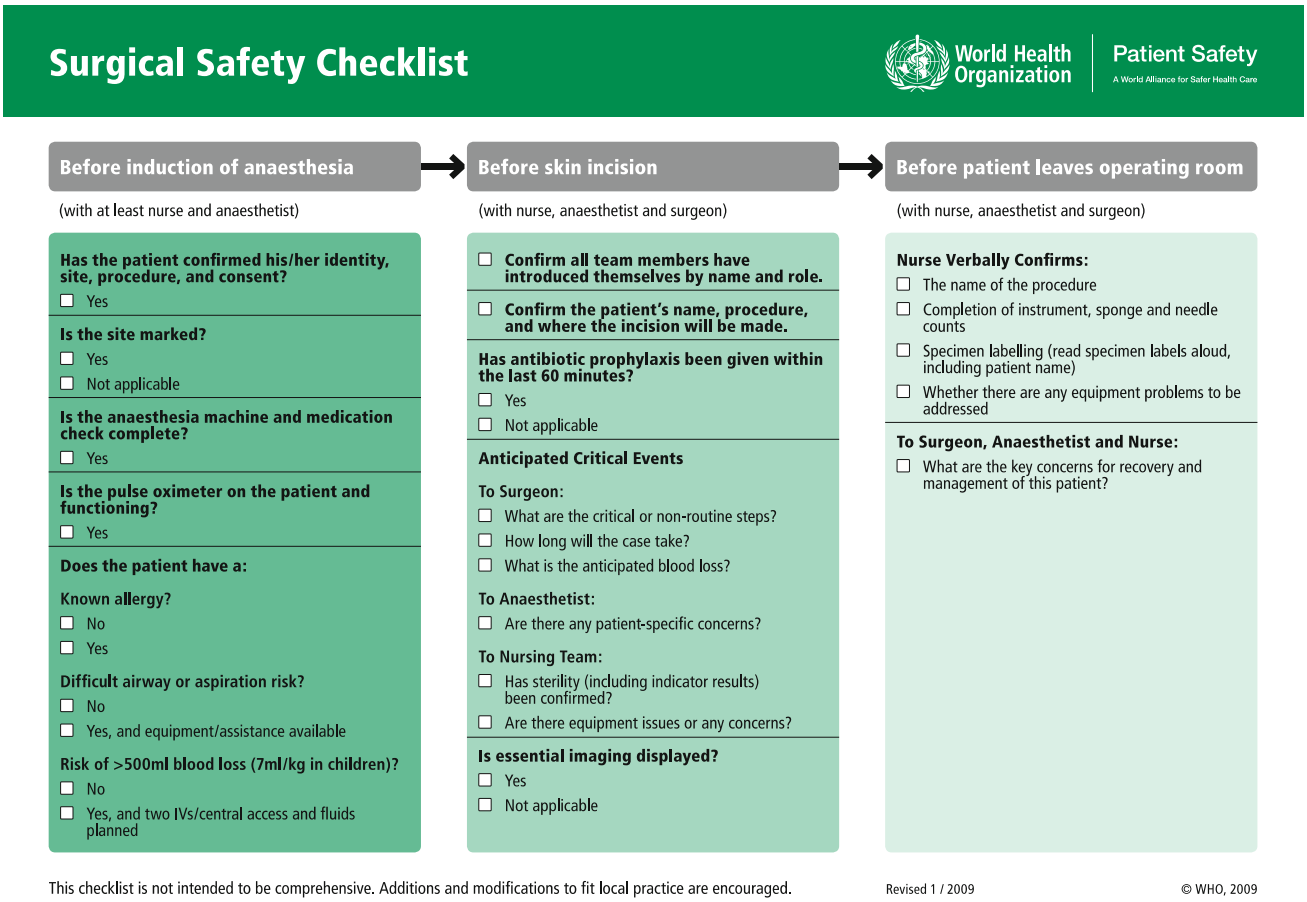

Fig. 1 The WHO Surgical Safety Checklist or something similar is part of routine practice in many settings. It demonstrates how safety tasks can be allocated to specific pause points in the care routine (http://who.int/patientsafety/safesurgery/en/index.html, reproduced with permission)

medicine has far exceeded our capacity to understand and process all inputs and outputs, and we make errors of commission and omission with startling regularity. Thankfully, most errors are not injurious as they are either caught before directly impacting patients or their effects are negligible. We are under more scrutiny now than ever before, and with good reason. Previous estimates predict that as many as half of the deaths and complications following surgery in western countries are preventable.[1,2] Many of these injuries result from breakdowns in communication between team members.[3] Surgical care has plenty of room for improvement, and use of checklists should now be considered standard of care to help ensure adherence to safety steps known to prevent complications and limit errors that might contribute to patient harm[4] (Fig. 1).

How checklists work

In industrial safety lingo, checklists work in one of two basic ways typically described as "read-do" or "challenge-confirm". A "read-do" checklist is a list of items to consider or tasks to accomplish. The reader uses the checklist as a memory prompt to gather a set of materials or complete a series of chores. Grocery lists are a perfect example of this – as the customer walks through the aisles and fills a shopping basket, items are progressively ticked off the list until they are all collected. Likewise, "to do" lists allow an individual to complete a set of tasks, both major and minor; this helps ease the person's mind and ensures nothing on the list is overlooked. We use these kinds of lists in medicine all the time. A typical admonishment during internship is that there are two types of interns, those who write things down and those who forget. Nevertheless, these "to-do" lists rarely address the more complex causes of errors and patient harm.

"Challenge-confirm" checklists are somewhat more sophisticated, as they tend to be more formalized regarding structure and use. These checklists are usually (but not necessarily) employed by at least two individuals and are often incorporated into a formal process or task structure. A pilot's checklist is an example of this type of checklist (Fig. 2). In a two-person cockpit, the pilot and copilot read

Normal Checklists

777 Flight Crew Operations Manual

BEFORE TAKEOFF

Flaps ..... ___

AFTER TAKEOFF

Landing gear ..... UP
Flaps ..... UP

DESCENT

Recall ..... Checked
Notes ..... Checked
Autobrake ..... ___
Landing data ..... VREF___, Minimums___
Approach briefing ..... Completed

APPROACH

Altimeters ..... ___

LANDING

Speedbrake ..... ARMED
Landing gear ..... DOWN
Flaps ..... ___

SHUTDOWN

Hydraulic panel ..... Set

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Fig. 2 An example of a paper 747 pilot's checklist and an electronic 777 pilot's dashboard checklist demonstrating the concept of "challenge-confirm", where the responses are scripted. Delays are minimized since it is widely accepted as an integral part of safe operational culture and the sequence of events familiar and anticipated. Note the prompt for communication briefing, the second to last element of the electronic version (http://www.boeing.com/news/frontiers/archive/2006/april/i_ca3.html, both images reproduced with permission from Boeing Corporation)

aloud a checklist enumerating a series of safety checks and tasks. The reader "challenges" the other to perform the stated task or to "confirm" previous completion of the task, usually with a scripted reply that both understand to eliminate confusion. For example, the challenger might state a system to be evaluated – "brakes" – and the responder might reply – "released" – confirming that the task of releasing the brakes has been completed. It is ambiguous for the responder to reply "yes" as this does not inform the challenger (or anyone listening) as to the actual task performed. Many industry checklists, including medical checklists, are a combination of "read-do" and "challenge-confirm" formats, allowing individuals both to gather items and to accomplish tasks while performing the checklist. When checklists are integrated into the operational culture, such as in aviation, the tasks tend to be accomplished ahead of time or in an anticipated sequence, thus minimizing delays and interruptions while reading the checklist aloud and ensuring that all critical items are addressed.

Both "read-do" and "challenge-confirm" checklists share one important attribute, i.e., the ability to prompt dialogue. Verbalization, the "call outs" and discussion generated by completing a checklist, is tremendously important for medical checklists as it is for aviation and other complex systems. The more complex the system, the more important the dialogue; aviation checklists have prompted these dialogues through briefing sessions scripted into the checklist itself. These briefings help establish a teamwork environment and support crisis management should the need arise. More than any single item on the checklist, these intangible and unquantifiable attributes foster communication patterns that facilitate adapting to phenomenally complex conditions and situations.

Use of checklists involves strategic timing. The most functional checklists are designed to integrate into a specific workflow pattern so as to minimize disruption while allowing identification of critical procedures as well as corrective action if necessary. In this way, omissions can be remedied in a timely and appropriate manner. This process, known as "error trapping",[5] acknowledges that individuals are prone to errors and that checklists help identify and adjust for these fallibilities before they cause harm.[6]

The checklist culture is critically valuable. For instance, use of checklists is ingrained in the aviation culture. Widespread adoption likely stems from the time when nearly all pilots trained in the military. Fighter and military pilots, who were used to protocols and routines, were mandated to incorporate a checklist into the flight structure, forcing its universal uptake. Of further importance, the pilot's fate was closely tied to the aircraft, adding an additional incentive. Checklist use has been an integral part of the safety culture of other high-reliability industries, including NASA and nuclear power. Again, the importance of safety is closely linked to the exposure to direct risk faced by participants in the safety process. This helps promote the use of checklists and their incorporation into routines. Regardless, physicians have not valued these systemic checks in the past, in large part because we are judged to be competent or intelligent based on our apparent capacity to remember things. This perception makes the use of a memory aid countercultural and anathema to routine practice.[7] This attitude is now changing with mounting evidence (described below) that perioperative checklists reduce complications and mortality and ensure compliance with known standards of care.

How to make a good medical checklist

The checklist development process can be divided into five distinct steps: timing, content and format, trial and feedback, formal testing and evaluation, and modification.[8] The timing of checklist use is critical, as checklist tasks and items must be associated with actions that allow for corrections and modifications prior to specific nonreversible events (e.g., skin incision). The ideal checklist can be used during a natural pause in workflow, as during the surgical pause before skin incision, in order to identify and remedy errors before their effects are spread to the patient. Content and format require a succinct and pointed checklist that identifies the most important elements in a process, i.e., elements whose omission or commission are critical to the process.[9] Typically, no more than five to seven items should be listed at any one safety check.[10] Checklist items should be written in a familiar font with upper and lower case letters, in simple but clear phrases or sentences that maintain the professional language of medicine.[11]

The concept of trial and feedback ensures rapid assessment of a checklist's functionality, and content and format can be adjusted accordingly based on the end user's experience. The strategy is similar to the Plan-Do-Study-Act model of quality control employed in manufacturing and helps calibrate the balance between brevity and comprehensiveness, which is difficult to determine without real-time assessment.[12] As such, it allows improvements in content and format before wider dissemination. Formal testing and evaluation allow for a rigorous assessment of the effects of a checklist on the process of care and compliance with the standards specified within it. In medicine, where checklists are still greeted with skepticism, formal evaluation provides positive feedback, justifies the effort involved in its implementation and use, and provides proof of efficacy. Finally, modification allows for ongoing improvements based on formal and informal assessments, ensuring that checklists remain relevant to a clinical situation and adapt to changing standards or newly identified lapses in care. Modification is also an important part of creating local ownership and increasing commitment to the process by multiple clinical disciplines. Fig. 3 shows the process used to create the World Health Organization (WHO) Surgical Safety Checklist, which can be replicated at a local level for quality improvement purposes.

What is the evidence?

As medical care has become more complex, checklists have gained a foothold in clinical practice. Medical checklists were used in the past, but it is only recently that they have been studied and more widely incorporated into the care process. One of the earliest widely acclaimed checklists was part of a bundled intervention to reduce catheter-associated bloodstream infection in the intensive care unit (ICU).[13] A set of well-accepted standards for placement of a central venous catheter (CVC) was established as part of a mandatory practice protocol in ICUs throughout Michigan State. Personnel in over 100 ICUs participated in the study, and throughout its duration, which included more than 300,000 catheter days, they showed a significant decrease in infection rates from baseline, with incidence-rate ratios declining progressively from 0.62 at zero to three months to 0.34 at 16-18 months following introduction of the intervention.

The World Health Organization created a Surgical Safety Checklist as a tool to help ensure that known standards of care were routinely incorporated into perioperative practice.[14] In a pre/post analysis of nearly 8,000 surgical patients, use of this 19-item checklist dramatically improved compliance with six measured safety steps, including confirmation of procedure and operative site, administration of antibiotics, estimation of blood loss, use of pulse oximetry, and preparation for a difficult airway. These improvements were associated with a 40% reduction in perioperative deaths, and overall complication rates decreased by a third. This effect was maintained even in urgent and emergency cases.[15] Over the last several years, further compelling evidence has shown the power of using perioperative checklists. In a large well-designed study of

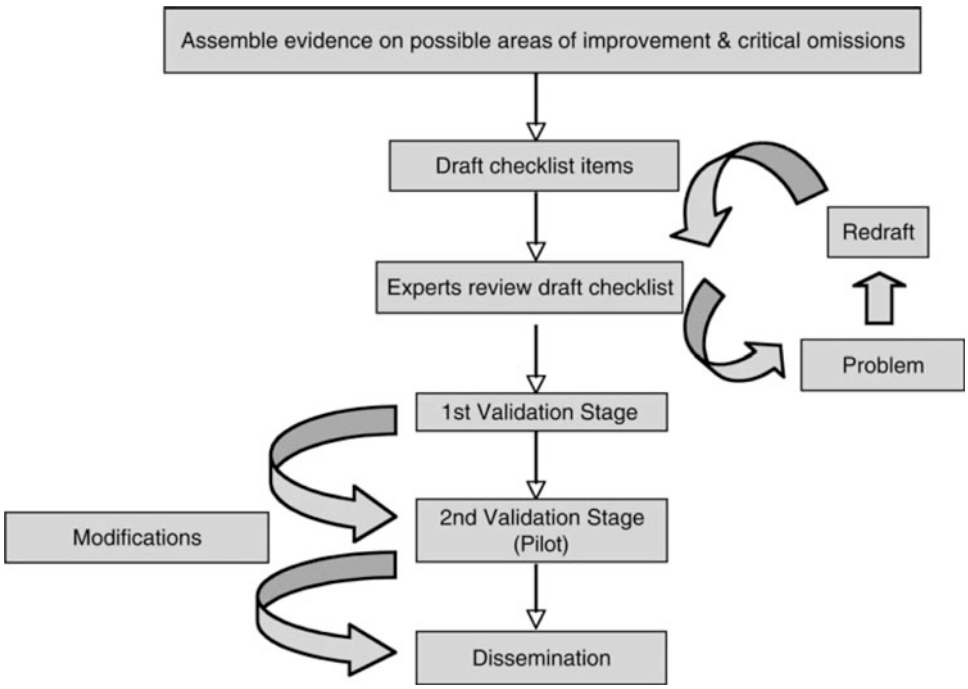

Fig. 3 Stepwise graphic outlining the process involved in developing the WHO Surgical Safety Checklist. Each step allowed various team member input into the items on the checklist, encouraging support and buy-in from the multiple disciplines involved in perioperative surgical care. This helped smooth its transition into clinical practice while ensuring it was functional, acceptable, and addressed meaningful safety issues without becoming overly complex or time-intensive (from *Weiser TG, Haynes AB, Lashoher A, et al.* Perspectives in quality: designing the WHO Surgical Safety Checklist. Int J Qual Safe Healthcare 2010; 22: 365-70, reproduced with permission)

7,580 patients in the Netherlands, a perioperative checklist was implemented throughout six Dutch hospitals with five other hospitals used as controls. In hospitals using the checklist, complication rates fell almost 40% and postoperative mortality fell nearly 30% when compared with the control hospitals.[16] In another recent study, the WHO investigation was virtually repeated in a separate Dutch hospital which showed that improved outcomes in postoperative patients were strongly related to compliance with the checklist.[17]

Since medical care frequently requires multiple disciplines to deliver multiple processes that occur in both sequence and parallel, "bundling" of care has become commonplace and checklists can provide a mechanism to ensure such bundles are carried out effectively. Even so, the impact of these care bundles has been difficult to evaluate. A number of studies have shown that organized bundles are effective in improving compliance even when teams believe they are already highly compliant. The most widely used bundles are for CVC insertion and prevention of ventilator-associated pneumonia (VAP). In the previously cited CVC study, a checklist was used to ensure that clinicians washed their hands, used full barrier precautions, scrubbed the skin with a chlorhexidine-based antimicrobial solution, avoided the femoral site for access, and removed unnecessary indwelling catheters in a timely fashion. Results of a Scottish study showed the effects of a ventilator bundle in ICU patients, i.e., the cases of VAP decreased from 32 per 1,000 ventilator days to 12 per 1,000 ventilator days in the post-intervention period.[18] This bundle ensured oral care with chlorhexidine, elevating the head of the bed to at least 30°, holding sedation medication each day as able, and implementing a ventilator weaning protocol. Each process was independently shown to reduce rates of VAP. While this evidence is indirect, it is supportive nonetheless.

Checklist implementation also has a place in low- and middle-income settings. Our own sub-analysis of low- and middle-income countries in the WHO Surgical Safety Checklist study showed more than a 40% reduction in overall complications and just over a 50% decline in death rates after checklist implementation compared with reductions of 30% and 33%, respectively, in high-income countries.[14] Another recent WHO initiative aimed at improving maternal and neonatal outcomes and reducing complications and deaths evaluated the effect of a checklist on 29 essential peripartum practices.[19] Results of the initiative showed an increase in the delivery of essential care practices during childbirth from an average of 10 at baseline to 25 following implementation.

Barriers to implementation are substantial. Given the deeply rooted culture of medicine, acceptance of checklists as part of the care process has faced challenges.[20] Surgical teams often believe they are performing at their peak and dismiss checklists as redundant, a waste of time, or "touchy-feely" instead of as part of the discipline and protocol of surgical preparation. Consequently, one of the biggest barriers to checklist use is persuading a team to use it and to commit to the process of interdisciplinary dialogue. Prompting a conversation may be the most important

process generated by the checklist, as it helps focus attention on critical concerns, opens lines of communication, and gives voice to multiple members of the surgical team who might otherwise not recognize their important roles in the safe delivery of care. It can also provide a unified vision regarding how a procedure should progress and what types of situations should trigger concern or further interdisciplinary discussions. Clearly, these qualities are difficult to measure, and there is much debate over how best to capture such results in quantitative and compelling ways.

Surgical checklists seem to be gaining wider acceptance. Concern has been expressed, however, regarding whether checklist use is sustainable and whether improvements can be maintained over time. Checklist use has shown efficacy over the long term in other medical settings. In a busy surgical ICU, a checklist used as part of daily rounds was evaluated over a 14-month time period. During implementation of the checklist in a single ICU service, there was marked improvement in adherence to components of the process in 570 trauma patients when compared with 577 patient controls from the year prior to checklist introduction.[21] Checklists cannot simply be dropped like a piece of paper on the desk and be expected to improve outcomes; they must be actively implemented and thoughtfully used. In an interesting study on the use of a checklist in an ICU, two medical ICU teams were evaluated for their compliance with six care standards using a checklist.[22] The intervention team included a "prompter" who alerted the team to the checklist if it was not actively used, while a control team used the same previously developed and implemented checklist as part of their daily rounds. The study included 140 patients in the prompted group, 125 control patients, and 1,283 patients in the pre-intervention group. The prompted group of patients had about a 60% lower risk-adjusted hospital mortality compared with the control groups. In addition, the prompted group had a shorter length of stay. The authors concluded that the use of prompting likely improved multiple processes of care and that the manner of checklist implementation is critically important if its use is to promote change in the medical profession.

Why you should care that your surgical team uses a checklist

In high-income countries, deaths following surgery are still cause for concern. Two recent studies looked at postoperative deaths per hospitalization in the USA over a ten-year period. In 1996, the in-hospital postoperative death ratio (deaths per operation) was 1.64-1.68%, which declined over the next ten years to 1.14-1.32% in 2006.[23,24] The cause for improvement is not clear, but the studies provide evidence that improvements are possible – some 60,000 deaths did not occur as evidenced by the decline in the death ratios. These mortality rates are similar in other countries, e.g., in the Netherlands, a review of 3.7 million surgical procedures at 102 hospitals over 15 years showed a perioperative mortality of 1.85%.[25] Furthermore, in these settings, the evidence suggests that up to half of the adverse events occurring in surgical patients are preventable. In low- and middle-income countries, this number is likely to be even higher. A recent study performed in hospitals from Egypt, Jordan, Kenya, Morocco, South Africa, Sudan, Tunisia, and Yemen showed that nearly one in ten patients suffered an adverse event; from 7-47% of these were directly attributable to operative errors, and over half of all adverse events might be avoided with improvements in communication and implementation of protocols and treatment guidelines.[26]

Surgical care requires a team of surgeons, anesthesiologists, and nurses to organize a host of preventative and therapeutic interventions in complex patients under complex conditions while accounting for patient comorbidities, allergies, and physiologic conditions. Getting all of this correct requires a degree of coordination that is more complex and subtle than almost any other multifaceted industry. Surgical teams have done a remarkable job thus far, yet it is incumbent on us as clinicians to maximize the safety and quality of care using whichever tools we have available. A checklist is a simple but effective tool that not only helps to ensure execution of important care processes but also helps to improve direct communication and coordination amongst team members. Use of checklists cannot be ignored as a mechanism to ensure consideration of the simple and complex steps that lead to improved postoperative outcomes.

Key points

- Checklists are used routinely in high-reliability organizations, such as aviation and nuclear industry, where the risk of error is potentially catastrophic. However, their utility in medicine is only just beginning to be recognized.
- Cultural attitudes toward use of checklists play an important role in their acceptance as part of the care process.
- Checklists work through a process described as either "read-do" or "challenge-confirm", depending on the tasks involved. In medicine, both types of checklists are used, but a challenge-confirm strategy is often most useful when multiple teams are involved in care, such as in the operating room.

- Checklists can help prompt and promote communication, but they cannot substitute for poor processes of care. However, failures during checklist execution can highlight system problems.
- Checklist implementation must take into account the local culture of the operating room and must be flexible enough to allow physicians to engage in the process of care.

Competing interests None declared.

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