Research Article

Should military robots designed to evacuate injured soldiers from the battlefield carry small arms for self-defence and are the technological challenges involved insurmountable?

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Abstract

While medical personnel are protected from attack under the laws of war, they are permitted to carry small arms for self-defence and the defence of those in their care in acknowledgement of the reality that they are sometimes unlawfully targeted. Robots whose function is to extract wounded combatants are being developed and, like human medical personnel, are at risk of being unlawfully targeted. This article argues that extraction robots should be armed to protect themselves and those in their care to achieve the goals of the Geneva Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field (the Convention) to the fullest extent. However, there are also technological challenges to be assessed. Ultimately, this paper argues that the technological challenges are not insurmountable, although further work and development of the technology is required to achieve a satisfactory standard. First, being armed enables the robot to avoid incapacitation which in turn allows it to continue to assist the wounded, reducing human suffering and enhancing the dignity of the wounded. The ability to defend wounded in its care achieves the same ends. Taking into account the challenges involved in translating rules of war into code, programming should set a high threshold of certainty of unlawful attack before force is used in order to recognise the complexity and confusion of combat situations and avoid the possibility of

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the robot losing protected status. In addition, to comply with proportionality and necessity requirements under the doctrine of self-defence, and to further minimise the chance of illegitimate force (particularly lethal force) being exerted, ERs should be equipped with communicative capabilities and non-lethal response options. Technology therefore has a role in limiting potential negative consequences of arming ERs.

Keywords extraction robots • self-defence • Geneva Convention • technological challenges • arming robots

I Background

Under the laws of war, medical personnel, medical equipment, and the wounded and sick are absolutely protected from attack.[2] However, the laws of war are not always respected.[3] In order to counter this reality, human military medical personnel are permitted to carry personal weapons to defend themselves and those in their care.[4]

Extraction robots (ERs) designed to evacuate wounded soldiers from the battlefield are being developed.[5] However, as with human personnel, issues of unlawful targeting of these robots remain. Thus, the question arises as to whether ERs should also be given the capability to use potentially lethal force to defend themselves and patients. Especially considering the technological challenges related to programming complex rules and the potential difficulty in locating liability when things do go wrong.

The essay proceeds on the basis that ERs, if armed, would make the decision about whether to use force autonomously. The basis for this premise is that military technology

[2] Geneva Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field (1949), article 12.
[3] Ronald Arkin, "Lethal Autonomous Systems and the Plight of the Non-Combatant", in *The Political Economy of Robots*, ed. Ryan Kiggins (Cham: Palgrave Macmillan, 2018), 319.
[4] Geneva Convention, articles 15 and 22.
[5] Barb Ruppert, "Robots to Rescue Wounded on Battlefield", United States Army, published 22 November 2010, https://www.army.mil/article/48456/robots_to_rescue_wounded_on_battlefield; Charles J Murray, "Robotic Lifesaver", *Design News* 61, no. 6 (2006); Gary Martinic, "Glimpses of Future Battlefield Medicine: the Proliferation of Robotic Surgeons and Unmanned Vehicles and Technologies", *Journal of Military and Veterans' Health* 22, no. 3 (2014): 8.

trends towards autonomy.[6] For example, the Battlefield Extraction Assist Robot (BEAR) can carry a wounded soldier out of the battlefield but is currently controlled by a human operator.[7] However, there are plans to increase BEAR's autonomy.[8] For the purposes of the following discussion, autonomy means the robot can determine whether to use force without human intervention.[9]

This essay argues ERs should be armed to protect themselves and the soldiers they are removing from the battlefield. While robots do not have a self-preservation interest as humans do, they should nevertheless be capable of self-defence to achieve the goals of the Geneva Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field (the Convention) to the fullest extent. A self-defence capacity ensures the robot is able to assist the maximum number of injured soldiers by avoiding its own incapacitation. It may then go on to remove soldiers from the field for further treatment, reducing human suffering and enlarging the dignity of the wounded. The ability to defend wounded in its care achieves the same ends. In addition, the Convention's requirement to protect the wounded supports defensive ability.

However, recognising some challenges with the technology in operationalising ERs with defensive capabilities, programming should set a high threshold of certainty of unlawful attack before force is used in order to recognise the complexity and confusion of combat situations and avoid the possibility of the robot losing protected status. Doing so also recognises the ambiguity and value judgments inherent in the laws of war which can be difficult to "translate" into programming. Setting higher thresholds before force is used reduces the chance of mistakes when applying coded ethics to the real world. For the

[6] Human Rights Watch, *Losing Humanity: the Case Against Killer Robots* (United States of America: Human Rights Watch, 2012), 3.
[7] The Economist, "Caught in a BEAR Hug", *The Economist* 398 (2011); Martinic, "Glimpses of Future Battlefield Medicine", 8.
[8] Ruppert, "Robots to Rescue Wounded on Battlefield"; Murray, "Robotic Lifesaver"; Martinic, "Glimpses of Future Battlefield Medicine", 8.
[9] Georg Heppner and Reudiger Dillmann, "Autonomy of Mobile Robots" in *Dehumanisation of Warfare* eds. Wolff Heintschel von Heinegg, Robert Frau and Tassilo Singer (New York: Springer International Publishing, 2018), 80-81; Ronald Arkin, *Governing Lethal Behaviour in Autonomous Robots* (New York: CRC Press, 2009), 37.

same reasons, ERs should also be equipped with defensive capabilities short of lethal means, with lethal force only used as a last resort.

The following discussion is related to, but distinct from, the debates around the use of autonomous weapons systems in armed conflict. Briefly, there are a range of concerns with lethal autonomous weapons systems.[10] Loss of clear lines of liability is one concern,[11] as is the possibility of making war worse, as killing is made easier when responsibility can be passed on to an autonomous system (putting the proportionality requirement of military action under threat).[12] Lethal autonomous weapons systems also may make war more likely, as they may reduce death and injury to human soldiers of the belligerent using the system, so the cost of waging war is reduced.[13] If war is seen as a less costly exercise in terms of sacrifice of the population,[14] it becomes a more palatable response and political barriers are removed.[15] In addition, the proliferation of arms may be exacerbated if the development of lethal autonomous weapons systems leads to an arms race.[16]

While these debates inform broader context, this paper focuses on a slightly different facet of the use of automated force. Instead of engaging with the question of offensive force and active waging of war, this paper is concerned with responsive and protective force. The focus here is twofold. First, whether it is at all justifiable to use automated defensive force in circumstances where there is an attack on a protected activity (in this case, providing medical care). Second, if justifiable, the technological challenges which need to be overcome and the technological solutions that might address some of those challenges. While I do use an analogy to offensive lethal autonomous weapons systems, it is primarily because many of the same *technical* challenges arise. For

[10] See for example Vincent C Muller, "Autonomous Killer Robots are Probably Good News" in *Drones and Responsibility: Legal, Philosophical and Socio-Technical Perspectives on the Use of Remotely Controlled Weapons* eds. Ezio Di Nucci and Filippo Santoni de Sio (London: Ashgate, 2016), 79-81.
[11] Peter W Singer, "Military Robots and the Laws of War", *The New Atlantis* 23, (2009): 46.
[12] Muller, "Autonomous Killer Robots", 79.
[13] Gary E. Marchant et al., "International Governance of Autonomous Military Robots" *Columbia Science and Technology Law Review* XII (2011): 285; Singer, "Military Robots", 42.
[14] Marchant et al., "International Governance", 185.
[15] Muller, "Autonomous Killer Robots", 80.
[16] Muller, "Autonomous Killer Robots", 80.

example, where liability is located for errors, and the difficulty of turning laws of war into programming.

II The Convention

A Protections and obligations

It is first important to understand the Convention, as it provides the context in which ERs operate. The Convention creates protections against direct attack for military medical personnel, equipment, and wounded or sick combatants.[17] The underlying rationale is to protect human dignity and minimise human suffering during armed conflict.[18] Ultimately, any decision as to whether ERs should be armed for defence purposes should further the Convention's underlying aim.

Medical personnel are afforded absolute protection by Article 24.[19] Without protection, their ability to carry out their work to achieve the purpose of the Convention would be significantly negatively impacted.[20] Patients are also afforded absolute protection under Article 12, requiring the wounded or sick "shall be respected and protected in all circumstances".[21] Attempts on wounded or sick soldiers' lives are strictly prohibited, as is other violence against them.[22]

[17] Laurent Gisel, "Can the Incidental Killing of Military Doctors Never be Excessive?" *International Review of the Red Cross* 95, no. 889 (2013): 215.
[18] Lindsey Cameron, Bruno Demeyere, Jean-Marie Henckaerts, Eve La Haye and Heike Niebergall-Lackner, "The Updated Commentary on the First Geneva Convention – a New Tool for Generating Respect for International Humanitarian Law", *International Review of the Red Cross* 97, no. 900 (2015): 1210 and 1219.
[19] Geneva Convention, article 24.
[20] International Committee of the Red Cross, *Commentary on the First Geneva Convention: Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field* (Cambridge: Cambridge University Press, 2016), 194; Cameron et al, "Updated Commentary", 1211.
[21] Geneva Convention, article 12.
[22] International Committee of the Red Cross, *Commentary,* 1397.

Article 12 also imposes obligations on others in relation to the wounded. While the concept of respect requires a negative action in refraining from attacking,[23] the concept of protecting imposes positive obligations of coming to someone's defence.[24] To best achieve the Convention's aims, the obligation to protect should be interpreted broadly to include protection against harm by others, combat situations, natural hazards, and dangers arising from their medical condition.[25]

Article 15 imposes obligations to search for and collect the wounded and sick[26] to ensure they are not left without medical attention, which again reflects the purpose of the Convention as a whole.[27] Under the Article 15 obligation, medical personnel are called on to guard and protect the wounded, potentially resorting to weapons if necessary.[28] Although not explicit in the article itself, the protection is likely to be against friendly and enemy forces.[29]

B Use of weapons

To facilitate their important role in operationalising the aims of the Convention, human military medical personnel are permitted to carry and use weapons. The arming of medics recognises they are increasingly the object of attacks during wartime.[30] The arming of medical personnel for defensive purposes does not deprive them of their protected status,[31] because medical personnel cannot be asked to sacrifice themselves when unlawfully attacked.[32] The general understanding (in the absence of explicit

[23] Alexander Breitegger, "The Legal Framework Applicable to Insecurity and Violence Affecting the Delivery of Health Care in Armed Conflicts and Other Emergencies", *International Review of the Red Cross* 95, no. 889 (2013): 108.
[24] Gisel, "Incidental Killing of Military Doctors", 222.
[25] International Committee of the Red Cross, *Commentary,* 1361.
[26] Geneva Convention, article 15.
[27] International Committee of the Red Cross, *Commentary,* 1479.
[28] International Committee of the Red Cross, *Commentary,* 1499; Henri Coursier, Oscar M Uhler, and Jean Pictet, *The Geneva Conventions of 12 August 1949: Commentary* (Geneva: International Committee of the Red Cross, 1952), 152.
[29] International Committee of the Red Cross, *Commentary,* 1498.
[30] Vivienne Nathanson, "Medical Ethics in Peacetime and Wartime: the Case for a Better Understanding" *International Review of the Red Cross* 95, no. 889 (2013): 209.
[31] Geneva Convention, article 22.
[32] Coursier, Uhler, and Pictet, *Commentary,* 203.

guidance in the Convention itself) is that only small, personal weapons are permitted for use in this manner.[33]

"Defence" in this context is to be understood narrowly to respond to unlawful violence against the medical personnel or their patients,[34] and therefore excludes acts harmful to the enemy.[35] Defence also does not cover situations where the enemy advances and seizes control of the area in which the medical activities are being carried out, nor in situations of capture of the medical personnel and patient.[36] In addition, resistance to verification procedures by the enemy to ensure medical activities are indeed being performed is not legitimate.[37] Force must only be resorted to when it is obviously necessary.[38]

C Non-discrimination

Under Article 12, the wounded or sick must be treated on the basis of non-discrimination, requiring even enemy combatants to be cared for to the same standard as allied soldiers.[39] The only permissible distinction is grounded in principles of medical triage,[40] so the provision of care is based on medical need rather than affiliation.[41] This obligation is augmented by general medical ethics, which continue to apply in wartime.[42]

[33] International Committee of the Red Cross, *Commentary*, 1864. The understanding was reached around the time of the Second Geneva Convention for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of Armed Forces at Sea.
[34] International Committee of the Red Cross, *Commentary,* 1866.
[35] International Committee of the Red Cross, *Commentary,* 1867.
[36] International Committee of the Red Cross, *Commentary,* 1867.
[37] International Committee of the Red Cross, *Commentary,* 1867.
[38] Coursier, Uhler, and Pictet, *Commentary,* 203.
[39] International Committee of the Red Cross, *Commentary,* 1337 and 1392.
[40] Coursier, Uhler, and Pictet, *Commentary,* 140.
[41] Nathanson, "Medical Ethics", 196.
[42] Leonard S Rubenstein, "A Way Forward in Protecting Health Services in Conflict: Moving Beyond the Humanitarian Paradigm", *International Review of the Red Cross* 95, no. 890 (2013): 334; World Medical Association's Declaration of Geneva, 2017; Nathanson, "Medical Ethics", 196; M Goniewicz and K Goniewicz, "Protection of Medical Personnel in Armed Conflicts", *European Journal of Trauma and Emergency Surgery* 39 (2013): 108.

As a result of the non-discrimination principle found in the Convention, any defence capability exercisable by ERs would need to be equally applicable against its own forces as enemy combatants. The reality of the non-discrimination principle in this context means as a policy decision, militaries may not want to develop ERs with defence capabilities if it runs the risk of operating against their own soldiers. However, as a principled argument against ER defence capabilities, it is not a particularly strong one because human medical personnel have the same obligations to use force against their own side if necessary to protect those in their care. Consequently, an ER with defence capacities which are compliant with the non-discrimination principle found in the Convention would have the same effect as a human performing medical duties in the field – the possibility that those defensive capabilities will be exercised against their own side.

III Defence and ERs

The use of ERs without defensive capabilities already facilitates the achievement of the Convention's aims. The obligation to collect the wounded is not absolute, and medics are not required to put themselves at risk disproportionately.[43] Consequently, medical personnel are not expected to continue despite danger.[44] Using ERs therefore reduces risk to humans who are no longer required to enter dangerous areas to find and retrieve casualties.[45] In addition, ERs may be used in situations where it would be too risky to require humans to perform recovery operations (or where the terrain is inaccessible), meaning the wounded are collected when they might otherwise be left in the field.[46] An ER therefore creates opportunities for assistance that may otherwise not be possible.[47] From this position, the use of ERs can already be said to aid in the achievement of the

[43] International Committee of the Red Cross, *Commentary,* 1487.
[44] Nathanson, "Medical Ethics", 209; Breitegger, "Legal Framework", 110.
[45] Andrew C Yoo, Gary R Gilbert, and Timothy J Broderick, "Military Robotic Combat Casualty Extraction and Care" in *Surgical Robotics: Systems Applications and Visions,* eds. Jacob Rosen, Blake Hannaford, Richard M Satava (New York: Springer, 2011), 13 at 15.
[46] Charles HC Pilgrim and Mark Fitzgerald, "Novel Approaches to Point of Injury Case Utilising Robotic and Autonomous Systems", *Journal of Military and Veterans' Health* 30, no. 4 (2022): 8.
[47] Yoo, Gilbert, and Broderick, "Extraction and Care", 16.

goals of the Convention, even without defence capabilities as medical personnel and the wounded both benefit.

However, the benefit of creating opportunities for extraction by ERs where it would otherwise not be possible is impacted by the reality that medical workers are increasingly the object of unlawful attacks.[48] Similarly, it is likely that ERs would also be targeted, and therefore limiting the circumstances in which extractions are successful. While the fact that rules are broken does not lead to the conclusion they are irrelevant,[49] meaning that we should continue to insist that they are followed, we need to be mindful of the reality of the situation. Recognising the reality that rules are broken should be accounted for where possible to allow for maximisation of the Convention's objectives, even in the face of unlawful attacks. In fact, this is recognised by the rule itself allowing for human medical personnel to respond to attacks on themselves and their patients. Some of the negative effects of unlawful attacks can therefore be further mitigated by allowing ERs to also benefit from the use of small weapons in defence of themselves and patients.

A Self-defence

Traditional principles underpinning the Convention and self-defence appear to tell against the ability for an ER to use force in self-defence. The Convention is anthropocentric:[50] its principles are humanity, dignity, reduction of suffering, and preservation of life.[51] It is these principles which justify permitting medical personnel to use weapons defensively.[52] The principles of protection of autonomy and the right to life underpinning the doctrine of self-defence generally also suggest self-defence is

[48] Nathanson, "Medical Ethics", 209.
[49] Martin Cook, "Ethical Issues in War: an Overview", *U.S. Army War College Guide to National Security Policy and Strategy* (Strategic Studies Institute, US Army War College, 2006), 21.
[50] Tim McFarland, "Factors Shaping the Legal Implications of Increasingly Autonomous Military Systems", *International Review of the Red Cross* 97, no. 900 (2015): 1336; Peter Asaro, "On Banning Autonomous Weapon Systems: Human Rights, Automation, and the Dehumanisation of Lethal Decision Making", *International Review of the Red Cross* 94, no. 886 (2012): 700.
[51] Goniewicz and Goniewicz, "Protection of Medical Personnel", 109.
[52] International Committee of the Red Cross, *Commentary,* 1948.

fundamentally tied to humanity.[53] These considerations are not applicable to a piece of equipment like a robot, such that there is little legitimacy in any use of force to defend itself. In addition, there is no personal danger to the robot and no drive for survival.[54] We allow the arming of medical personnel because we do not expect them to completely ignore their own interests and sacrifice themselves in the face of an unlawful attack.[55] General self-defence doctrine also sometimes justifies force on the basis that there is choice between self-preservation and violence to another.[56] Again, the lack of self-interest on the part of the robot points away from the necessity of self-defensive capabilities. Cumulatively, the anthropocentric nature of the Convention and self-defence doctrine, and the lack of a self-interest might indicate an ER should not defend itself against attack.

However, the situation is more complex. Medical personnel are afforded protection even when not actively treating a patient in recognition that their services will have future benefit to the sick and wounded.[57] Other parts of the Convention supplement the conclusion that future assistance is a relevant consideration for whether ERs should be permitted to defend themselves: Article 35 protects medical transports from attack whether or not there are wounded soldiers on board,[58] and further requires the transport not be held up or obstructed.[59] Otherwise, the wounded would not be able to be quickly and safely moved to a location where care is available.[60] As to weapons attached to medical transports, Article 35 does not expressly permit medical transports to be armed but the reality is they may require weapons to protect against unlawful attack,[61] particularly since they are likely to be travelling through volatile areas.[62]

[53] Robert Leider, "Justifying Self-Defence, Defence of Others, and the Use of Force in Law Enforcement" (Doctor of Philosophy Dissertation, Georgetown University, 2009).
[54] Patrick Lin, George Bekey, and Keith Abney, *Autonomous Military Robotics: Risk, Ethics, and Design* (California: United States Department of Navy, Office of Naval Research, 2008), 25.
[55] Coursier, Uhler, and Pictet, *Commentary,* 203.
[56] Leider, "Justifying Self Defence", 61.
[57] International Committee of the Red Cross, *Commentary,* 1948; Breitegger, "Legal Framework", 108.
[58] International Committee of the Red Cross, *Commentary,* 2367.
[59] International Committee of the Red Cross, *Commentary,* 2387.
[60] International Committee of the Red Cross, *Commentary,* 2367.
[61] International Committee of the Red Cross, *Commentary,* 2394.
[62] International Committee of the Red Cross, *Commentary,* 2395.

Protection for medical transports before they are actively being used to transport soldiers, and the ability to defend transports against unlawful attacks suggests the justifications for primary defence (rather than defence of a third party) are grounded not just in human value, but in the ability to provide future care. Relevant considerations in relation to self-defence of a robot are therefore broader than simply whether a human life is at stake.

The principles of the Convention provide a sound basis for allowing robots to act in their own self-defence when subject to an unlawful attack in the interests of furthering future benefit to the wounded. On this basis ERs should be permitted to use force in self-defence.

B Defence of others

The wounded are also targeted directly during times of war, even while enjoying protections afforded by the Convention.[63]

The justifications for using force to defend patients is more straightforward and provides a stronger argument in favour of arming ERs. Clearly, defence of a patient satisfies the anthropocentric underpinnings of the Convention and the doctrine of self-defence set out above since a human life is at stake. Acting to prevent that person's life being taken as a result of an unlawful attack respects the inherent human worth of the individual and their dignity. In addition, the potential victim's interest in self-preservation and right to life interest may not be able to be vindicated by their own action, due to wounds. An ER is therefore justified in stepping in to act on the wounded individual's behalf to protect those interests.

Furthermore, the Convention has several places where an obligation to come to the defence of a wounded soldier is imposed.[64] These obligations to actively protect and

[63] Vincent Bernard, "Violence Against Health Care: Giving in is Not an Option" *International Review of the Red Cross* 95, no. 889 (2013): 5.
[64] Geneva Convention, articles 12 and 15.

defend the wounded suggest a *requirement* that an ER, if possible, should defend patients in its care.[65] A robot with the ability to defend patients with force therefore contributes to the attainment of the goals set out in the Convention and should be permitted.

IV Technical issues

Although on a principled level we may want to equip ERs defensive abilities, their operation in practice may go against the desirability of such a capability. If armed ERs are unable to meet Convention and self-defence standards, then they will cause more harm than good and should not be permitted.

A Programming

As with lethal autonomous weapons systems (LAWS), ERs able to use lethal force require ethical decision-making because they can take a human life. Any use of force must be compliant with legal and ethical constraints.[66] The following discussion will use literature on LAWS when assessing whether ERs should be able to use defensive force, since in both applications human life is at stake and action needs to be constrained by the laws of war.[67] While the rules legitimising the use of force are different, there are comparable underlying concerns about programming being able to implement the laws of war.

[65] Geneva Convention, articles 12 and 15.
[66] Arkin, *Governing Lethal Behaviour,* 10; Robert Sparrow, "Killer Robots: Ethical Issues in the Design of Unmanned Systems for Military Applications" in *Handbook of Unmanned Aerial Vehicles* eds. Kimon P Valavanis and George J Vachtsevanos (Dordrecht: Springer, 2015), 2972.
[67] Peter Asaro for example argues that concerns about autonomous lethal weapons in armed conflict can also be applied to autonomous systems used for domestic policing, crowd control, and other security applications related to the use of force: see Asaro, "On Banning Autonomous Weapons Systems", 689.

There is significant debate about whether the principles of discrimination and proportionality can be programmed into LAWS,[68] and regardless is a huge programming challenge.[69] The laws of war are abstract, and require situational evaluation and interpretation not easily reduced to a programmatic process.[70] In particular, the Convention does not easily translate into binary options for execution by the robot.[71] "Rules" have a number of exceptions and are open to different understandings even within the same context,[72] and often guidance on how to apply the Convention does not give firm answers but a means of navigating many levels of contextual considerations.[73] Sometimes rules conflict.[74] As with proportionality and discrimination in targeting decisions under the laws of war, rules related to the protection of the wounded and self-defence are not as straightforward as they might appear, meaning similar concerns about their ability to be operationalised in programming apply.

The right to self-defence is limited for both humans and robots.[75] As set out in more detail above, "defence" is to be understood narrowly,[76] only being permitted in order to respond to unlawful violence against the medical personnel or their patients.[77] In addition, force must only be resorted to when it is obviously necessary.[78] Defence under the Convention is extremely nuanced with multiple parameters and exceptions, and the ER needs to be able to distinguish between all of these situations. Acting outside of these parameters will lead to the ER committing a harmful act towards the enemy, and

[68] See generally Arkin, *Governing Lethal Behaviour* and Noel Sharkey, "The Inevitability of Autonomous Robot Warfare", *International Review of the Red Cross* 94, no. 886 (2012).
[69] Jakob Kellenberger and Philip Spoerri, "International Humanitarian Law and New Weapon Technologies", *International Review of the Red Cross* 94, no. 886 (2012): 812.
[70] Arkin, *Governing Lethal Behaviour,* 93-94; Hans Geser, "Military Robots in Today's Asymmetric Wars", Hans Geser: Online Publications, published January 2011, http://geser.net/internat/t_hgeser8.pdf, 17.
[71] Peter W Singer, "Military Robots and the Future of War", 4 March 2009, TED Talk.
[72] Arkin, *Governing Lethal Behaviour,* 93-94.
[73] Asaro, "On Banning Autonomous Weapons Systems", 698.
[74] Thomas Hellström, "Terminator ethics What's right and wrong with killer robots?", Department of Computing Science Umeå University Sweden, published 2010, https://people.cs.umu.se/thomash/reports/Terminator%20ethics%20DRAFT.pdf.
[75] Singer, "Military Robots and the Laws of War", 46.
[76] For example it excludes acts harmful to the enemy, defending against advances of the enemy, defending against capture by the enemy, and defending against verification procedures – see Geneva Convention.
[77] International Committee of the Red Cross, *Commentary,* 1866.
[78] Coursier, Uhler, and Pictet, *Commentary,* 203.

result in loss of protection.[79] Losing its protection would be detrimental to the ER's role in achieving the goals of the Convention as it would place it in a worse position than if it did not have defence capability. In arming ERs we therefore need to be confident of compliance with the Convention.

Further complexity arises from the doctrine of self-defence itself. Force must be necessary and proportionate.[80] United States Marine Corps training shows the difficulty involved in making defensive assessments in wartime: imminent does not necessarily mean immediate, and proportionality requires use of force that is reasonable in type, length and scope.[81] These are all value judgments which can be open to interpretation. Failure to assess these factors can lead to unnecessary harm to a human, which works against the aims of the Convention and delegitimizes the arming of ERs.

Obtaining sufficient and accurate information to even begin to make these decisions is itself an issue in the context of war. Systems require high quality inputs to make acceptable decisions.[82] Environmental factors like low visibility and video quality can reduce reliability of visual sensors in recognising objects.[83] Accuracy and clarity in terms of visual sensors is important for identifying features in the environment that may indicate aggression, as opposed to an approach for the purposes of capturing the ER and patient. If audio sensors are used, ambient noise and emotions in the voices of those the robot interacts with can distort the reliability of speech recognition.[84] Interpreting speech is particularly important because soldiers interacting with an ER may be attempting to communicate and if this is incorrectly categorised as threatening,

[79] Breitegger, "Legal Framework", 112.
[80] Marco F Bendinelli and James T Edsall, "Defense of Others: Origins, Requirements, Limitations and Ramifications", *Regent University Law Review* 5, (1995): 166 and 168; Leider, "Justifying Self-Defence", 5.
[81] United States Marine Corps Training Command, *Introduction to Rules of Engagement* (United States Marine Corps, Student Handout B130936), 21.
[82] Arkin, *Governing Lethal Behaviour*, 4.
[83] Abhinav Kumar and Feras A Batarseh, "The Use of Robots and Artificial Intelligence in War", London School of Economics, published 17 February 2020, https://blogs.lse.ac.uk/businessreview/2020/02/17/the-use-of-robots-and-artificial-intelligence-in-war/.
[84] Kumar and Batarseh, "Use of Robots".

an illegitimate use of force may occur. If accuracy cannot be assured, ERs should not be armed.

While the limitations of obtaining sufficient and accurate information discussed above are a challenge, there are also other sources of information available to ERs which may enhance the information gathering capability of an ER. While sensors based on human senses described above may not provide enough information or sufficiently high-quality information, there is also the possibility future development will lead to information gathering options better than human senses.[85] Arkin identifies wall-penetrating radars as one such technology.[86] Greater information will therefore be available to an ER about the nature of a threat than might otherwise be discernible by a human. Added to this, robots can synthesise larger amounts of information faster without emotional clouding, and decisions are more likely to be better informed and rational than a human's response.[87] All this information can also accommodate contrary indications, rather than humans who may fall victim to "scenario fulfilment" where information contrary to their interpretation of a situation is excluded from consideration or fitted to the existing belief.[88] In this respect, robots may be able to perform "better" than a human by avoiding a potentially illegitimate self-defence action and so should be equipped with defensive capabilities. It will be a matter of assessing the adequacy of information tools that ERs have available to them and how they perform in war zones as they develop and become more advanced.

In addition, perfection is not necessarily the goal. As Arkin comments, humans themselves are imperfect, but if robots can outperform them (which seems possible) then some level of residual fallibility remains acceptable, given there is still an overall improvement.[89] This is an achievable but crucial threshold to meet.[90] With continual technological development, it is also reasonable to assume autonomous systems will

[85] Arkin, *Governing Lethal Behaviour,* 29.
[86] Arkin, "Lethal Autonomous Systems and the Plight of the Non-Combatant", 319.
[87] Arkin, *Governing Lethal Behaviour,* 29-30.
[88] Arkin, *Governing Lethal Behaviour,* 30.
[89] Arkin, *Governing Lethal Behaviour,* 39.
[90] Lin, Bekey, and Abney, "Autonomous Military Robotics", 2.

improve and be appropriate for use in a greater number of situations.[91] Consequently, arming ERs should not be precluded on the basis programming might not be able to account for every situation. Where there are residual concerns, further mitigations can be embedded in the ER's programming to ensure the chance of a mistake is minimised and support the benefit of arming ERs for defence.

B Thresholds

Concerns around uncertainty about what the rules permit and understanding of context can be addressed by setting particular thresholds before any force will be used. A robot is more able to act conservatively when information is unclear or in borderline cases.[92] This mitigates against the argument that information may be unreliable and actions misinterpreted, as well as the issue of rules being uncertain as to what is permitted. In this respect, errors can be avoided in cases where it is not clear use of force is warranted.

Another insulating factor is the lack of a drive for self-preservation in an ER and its durability. ERs are more durable than humans and can take direct fire at greater quantities and for longer.[93] ERs can therefore employ tactics to draw out true intentions of an approaching combatant before making a decision to respond, since it does not need to preserve itself at such an early stage.[94] Strong evidence of hostility could therefore be required before action is taken.[95] For example, the ER could wait to actually come under fire before returning fire, eliminating the need for pre-emptive action the way a human may consider necessary. This is also a benefit in defending others, as the ER can place itself between the patient and fire before responding with its own force. Performing reactive rather than proactive defence means complex assessments may be less necessary since reactive responses are more likely to be

[91] Jeffrey S Thurnher, "Feasible Precautions in Attack and Autonomous Weapons" in *Dehumanisation of Warfare,* eds. Wolff Heintschel von Heinegg, Robert Frau and Tassilo Singer (Cham: Springer, 2018), 115.
[92] Arkin, *Governing Lethal Behaviour,* 29.
[93] Martinic, "Glimpses of Future Battlefield Medicine", 4; Singer, "Military Robots", 43.
[94] Arkin, *Governing Lethal Behaviour,* 46.
[95] Arkin, *Governing Lethal Behaviour,* 120.

within the rules of war.[96] ERs can therefore require a high degree of certainty before force is applied, facilitated by their durability and lack of self-interest, meaning in clear cases the goals of the Convention are furthered without creating unnecessary harm against those same goals in ambiguous situations.

Added mitigations against inappropriate lethal defensive force can also be incorporated into an ER. Communicative functions and non-lethal response options can further reduce potential harm.[97] Generally under self-defence doctrine, de-escalation and non-lethal options are alternatives that should be considered and acted on if appropriate.[98] Again, durability of the robot facilitates taking these de-escalation and non-lethal measures before (lethal) force is employed, respecting the human-centred nature of the Convention and self-defence doctrines by preserving human life even where that human is presenting a threat.

Use of these safeguards warrant ERs being armed for defence, as the ends of the Convention can be better achieved while simultaneously minimising the risk that unauthorised force will be used.

C Liability issues

Despite precautions able to be taken in relation to the use of force by an ER, locating responsibility for when things go wrong is key. Increasing autonomy of artificially intelligent systems can create a greater responsibility gap,[99] but delegation of decisions to technology should not allow individuals to shift their moral and legal responsibility to comply with the Convention.[100] While some accountability gaps in legal regimes are

[96] Geser, "Asymmetric Wars", 13.
[97] Sparrow, "Killer Robots", 2978.
[98] United States Marine Corps Training Command, *Introduction to Rules of Engagement,* 21.
[99] Daniel W Tigard, "Artificial Moral Responsibility: How We Can and Cannot Hold Machines Responsible", *Cambridge Quarterly of Healthcare Ethics* 30, no. 3 (2021): 435; Human Rights Watch, *Losing Humanity*, 42.
[100] Vincent Bernard, "Science Cannot be Placed Above its Consequences", *International Review of the Red Cross* 94, no. 886 (2012): 464.

acceptable, persistent or frequent gaps are generally undesirable.[101] Failure to identify an appropriate locus of responsibility when ERs use force inappropriately may be a relevant reason to deny their use of weapons. Nevertheless, the accountability issues created by an autonomous ER using force impermissibly may be over-stated.

Having a level of autonomy, it might be appropriate to hold the ER itself accountable. While we may be able to assign moral responsibility to a robot because it takes morally significant actions,[102] Sharkey points out there is no significant way to punish a robot,[103] and Arkin suggests doing so does not seem realistic under the current state of technology.[104]

However, it is not necessary to hold autonomous robots responsible for their actions. Even autonomous machines are just tools used by humans,[105] and robots are designed and used by humans such that engineers and commanders could remain liable under product liability and chain of command principles respectively.[106] In addition, as tools become more technical, there is a wider class of people who may have contributed to its creation, purchase, and use.[107] The class of those potentially liable is broadened beyond the military chain of command and combatants to include scientists, programmers and political actors.[108] The issue then is not lack of potentially responsible actors, but locating liability in a broad range of actors.[109]

[101] Muller, "Autonomous Killer Robots", 76-77.
[102] Tigard, "Artificial Moral Responsibility", 436.
[103] Noel Sharkey, "The Moral Case Against Autonomous and Semi Autonomous UAVs" in *Handbook of Unmanned Aerial Vehicles* eds. Kimon P Valavanis and George J Vachtsevanos (Dordrecht: Springer, 2015), 2930.
[104] Arkin, *Governing Lethal Behaviour,* 40.
[105] McFarland, "Legal Implications", 1316.
[106] Yoram Dinstein, "Autonomous Weapons and International Humanitarian Law" in *Dehumanisation of Warfare* eds. Wolff Heintschel von Heinegg, Robert Frau and Tassilo Singer (Cham: Springer, 2018), 20.
[107] Bernard, "Science", 464; Philip Alston, "Lethal Robotic Technologies: the Implications for Human Rights and International Humanitarian Law", *Journal of Law, Information and Science* 21, (2011): 51.
[108] Bernard, "Science", 464.
[109] Didier Danet, "Do Not Ban Killer Robots!", *International Conference on Military Technologies* 716, (2017): 720.

A commander or other individual in the command chain is commonly identified as a locus of responsibility.[110] Programmers are also at times identified.[111] Some argue it would be unjust to hold these actors accountable because they do not have effective control over the decisions made by the system.[112] However, this does not preclude a policy decision to allow for liability to be found. We frequently allow humans to be bound to obligations through informed consent even though there may be no inherent moral duty to be subject to those responsibilities.[113] We could allocate a deliberate assumption of responsibility for the defensive actions of ERs to other parties, including politicians, military officials, soldiers, designers or programmers.[114] Where no one is willing to explicitly accept this liability, we can say the technology should not be deployed.[115] In this respect, lack of liability alone is not a justification for precluding the arming of ERs for defence.

Another argument asserting it is unfair to hold a particular individual or group accountable is based on the fact the error could equally be attributed to other actors.[116] This understanding fails to recognise normal fault attribution which occurs in legal settings regularly. Commanders can continue to be responsible for authorising use of robots in circumstances where a reasonable person may guess harm will occur.[117] Whereas if a failure to include in the programming a parameter of the law is the cause of the error, then it is more appropriate to hold the developer or manufacturer accountable.[118] Before ERs with defensive capabilities are introduced, clear lines of accountability should be established and parties involved in the creation and use of the

[110] Kellenberger and Spoerri, “New Weapon Technology”, 816.
[111] Human Rights Watch, *Losing Humanity*, 4.
[112] Arkin, *Governing Lethal Behaviour,* 38; Human Rights Watch, *Losing Humanity*, 4.
[113] Marc Champagne and Ryan Tonkens, “Bridging the Responsibility Gap in Automated Warfare”, *Philosophy and Technology* 28 (2015): 127.
[114] Arkin, *Governing Lethal Behaviour,* 40.
[115] Champagne and Tonkens, “Responsibility Gap”, 136.
[116] Sharkey, “Inevitability of Autonomous Robot Warfare”, 790-791.
[117] Singer, “Military Robots”, 47.
[118] Gary E Marchant, Braden Allenby, Ronald Arkin, Jason Borenstein, Lyn Gaudet, Orde Kittrie, Patrick Lin, George Lucas Jr, Richard O’Meara and Jared Silberman, “International Governance of Autonomous Military Robots” in *Handbook of Unmanned Aerial Vehicles* eds. Kimon P Valavanis and George J Vachtsevanos (Dordrecht: Springer, 2015), 2886.

technology should assume responsibility as appropriate in line with normal fault attribution principles.

Arguments that responsibility gaps should preclude the use of autonomous robots capable of using lethal force are, for the reasons above, insufficient to say that ERs should not be equipped with small arms for defensive purposes. Any responsibility gaps can be managed through existing laws governing liability, or by introducing a legal scheme specific to this kind of technology which allocates responsibility.

V Conclusion

Autonomous robots used to extract battlefield casualties should be equipped with small arms for defensive purposes in the same way human medics are. The ability to defend themselves and those in their care, while not based on traditional self-defence justifications, nevertheless is justifiable on the principle of maximisation of the goals of the Convention to reduce human suffering and enlarge human dignity during war.

Currently, the technological and practical ability of ERs to be armed presents further challenges, but also provides some answers. There are limitations in relation to sensors for information gathering within a difficult context of war, as well as the evaluative nature of the law of war not easily being translatable into programming. However, technology can be tailored to manage these limitations. Defensive capabilities should be defined narrowly to avoid mistakes arising out of unreliability of data or ambiguity arising out of the abstract nature of the laws of war. In addition, to comply with proportionality and necessity requirements under the doctrine of self-defence, and to further minimise the chance of illegitimate force (particularly lethal force) being exerted, ERs should be equipped with communicative capabilities and non-lethal response options. Ultimately, technology is not necessarily a complete bar to arming ERs for self-defence and defence of those in their care, but more work needs to be done around practical

programming solutions in order to achieve the ideals advocated for in this paper. Until we can be satisfied that the technology works appropriately and within suitable constraints, we should err on the side of caution and continue to rely on human or non-defensive ERs in the field. Prematurely introducing ERs with defensive capabilities carries the risk of degrading the status quo, rather than improving it.

Finally, accountability to ensure punishment for any breaches of the laws of war should also be assured through explicit assumption of responsibility by users of the technology if it is to be deployed. Explicit allocation of responsibility may be done consistently with normal fault attribution principles, depending on the type of fault which caused the error. For example, it may be most appropriate to hold developers responsible if they fail to include parameters which clearly need to be included to comply with the laws of war, whereas inappropriate use in the circumstances may be more readily attributed to commanders in the field who made the decision to use the ER.

All of this is not to negate the importance of continuing to advocate for observation of the laws of war as they relate to medical workers and those under their care. Although ERs present a potential partial solution to reduce the impacts of belligerents who ignore fundamental principles of the Convention, they are not a panacea and are unlikely to be operational in the immediate future. Issues around targeting of medical personnel and patients are current problems which need addressing in the present, particularly with ongoing concern about the targeting of medical personnel (and other protected individuals and groups) in Gaza.[119] To that end, continued international political pressure

[119] See for example “Gaza: ‘Facilities and Healthcare Workers are Being Targeted’”, Médecins Sans Frontières, 24 January 2024, https://msf.org.au/article/statements-opinion/gaza-facilities-and-healthcare-workers-are-being-targeted; Tlaleng Mofokeng, “Gaza: UN expert condemns ‘unrelenting war’ on health system amid airstrikes on hospitals and health workers”, Office of the United Nations High Commissioner for Human Rights, 7 December 2023, https://www.ohchr.org/en/press-releases/2023/12/gaza-un-expert-condemns-unrelenting-war-health-system-amid-airstrikes; and “WHO appeals for protection of the health system from further attacks and degradation of its capacity”, World Health Organisation, 4 December 2023, https://www.emro.who.int/media/news/who-appeals-for-protection-of-the-health-system-from-further-attacks-and-degradation-of-its-capacity.html.

and legal accountability for individuals and states responsible are also pieces of the solution.

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