Lessons for the Future of Counter IED (C-IED) Operations

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Abstract

Improvised Explosive Devices (IEDs) remain one of the most significant threats to conventional military forces. In spite of pioneering work by organisations such as the US Department of Defence's Joint Improvised Explosive Device Defeat Organisation, the operational response has often been uncoordinated and incoherent. Some nations have successfully procured more resilient vehicles to protect their personnel. Others have made ad hoc modifications that provide limited improvements at great financial cost. Some nations have developed advanced mine detection systems that seldom work reliably in the field. Others have relied on risk assessment procedures that are often forgotten under operational pressures. The following pages draw a number of more detailed lessons from IED attacks in Iraq and Afghanistan. In particular, it is argued that C-IED risk assessments must be updated to reflect changing local threat levels. They must also take into account the complacency that can expose vulnerabilities that will be exploited by insurgent forces. The comparison of previous attacks reveals wider problems. In many cases, personnel are exposed to increased levels of risk when they have to 'work around' routine equipment failures. In the aftermath of an IED blast, these failures have disastrous consequences as soldiers struggle to coordinate their response. In such circumstances procedures are often disregarded and communications protocols ignored. This reinforces the need for additional pre-deployment exercises strengthened by recent innovations in dealing with catastrophic accidents from civilian, safety-critical industries. The paper concludes by reiterating that operational pressures must not undermine the provision of specialised C-IED training both before and after deployment.

Introduction

Improvised Explosive Devices (IEDs) remain one of the most significant threats to conventional military forces around the globe. They have caused approximately 60% of all American combat casualties in Iraq and have been responsible for 50% of US combat casualties in Afghanistan (ref. 1). For British forces, the percentage of fatalities from IEDs in Afghanistan in closer to 80% and at twice the rate per 1,000 troops deployed than their US counterparts. In some areas, terrorist and insurgent groups have learned to improvise 'home brew' explosives from off the shelf ingredients. For example, a recent attack used a car bomb to detonate a gasoline tanker in Kabul; killing four civilians and an American soldier (ref. 2). Many other devices have been constructed from military munitions (ref. 3). For instance, IEDs have been constructed using the military grade munitions that were left unsecured in the aftermath of Operation Iraqi Freedom (refs. 4 and 5). The increased threat from IED attacks is partly explained by the ways in which tactics have been exchanged between insurgent forces. For example, Hezbollah developed the integrated use of suicide bombers and secondary devices following Israel's invasion into Lebanon (ref. 2). An initial detonation creates confusion; further devices then target the crowds that gather after the first attack. There are strong suspicions that members of Hezbollah, assisted by Iranian Revolutionary Guards, helped to transfer expertise in the use of IEDs to the local militias in Iraq and that these techniques were then passed to groups in Afghanistan by foreign fighters.

Military organisations have responded with a host of technical and operational counter measures including the use of jamming and sensing devices, rocket-propelled mine clearing systems, blast protection and force separation emplacements, upgraded vehicles and the increased use of rotary winged deployments etc. Rather than focus on particular technological counter-measures; this paper argues that we must learn as much as possible from previous incidents to reduce the risks associated with future attacks. The following pages, therefore, apply expertise gained in civilian accident analysis to analyse three different IED blasts. This is motivated by a range of criticisms that have been aimed at previous Boards of Inquiry, which were assisted by engineers without explicit training in accident or incident investigation techniques (refs. 6 and 7).

Jowz Valley, Afghanistan, October 2003

The first of the IED attacks considered in this paper occurred on the 2nd October 2003 in the Jowz valley, Afghanistan (ref. 8). At the time, it was unclear whether the blast was deliberately aimed at Canadian forces or

whether it was an accident involving legacy munitions from the Soviet invasion. This illustrates how a single event could trigger radically different recommendations depending on the findings from the subsequent investigation; reflecting differences in the threats posed by insurgent operations compared to those associated with residual mines. In this case, it was determined that a mine had been deliberately placed to attack coalition forces.

The Canadian units involved in this attack were operating under procedures that required engineers to 'prove' all routes in an area of operations before they could be used. The Improved Landmine Detection System (ILDS) commander, therefore, took a patrol to go over the Jowz valley road. Unfortunately, access limitations through a local village frustrated attempts to find the northern junction. Another unit was tasked to finish the operation. Using information from the Information Management System Mine Action (IMSMA) database and with input from an Engineering Support Communication Centre, they concluded that the route was 'Low Risk'. An Engineering Reconnaissance Sergeant carried out a further inspection to confirm this risk assessment. As a result, the proving operation was conducted by driving slowly over the route, looking for mines and unexploded ordinance, rather than by conducting a more meticulous patrol on foot before the road was opened.

In the 4 days before the blast, some 12 military vehicles had passed over the road. After a morning conducting patrols, a Sergeant again left the Camp using a different route and continued some three kilometres South West. They turned onto the Jowz Valley road and began to head North at a slow pace. They were unfamiliar with the route and did not want to increase the jolting for the two team members in rear facing seats of their Iltis. The Iltis is a lightweight, four-wheel drive vehicle similar to a Jeep. As they entered a dry river bed, the lead vehicle struck a TM-57 Anti-tank mine. The Iltis was blown some eight meters from the point of detonation. Two of the three crew members died instantly and the third received blast related injuries.

The second Iltis had not yet entered the wadi. However, the occupants of this vehicle also suffered minor injuries because there was inadequate spacing between the patrol. A Corporal in the second vehicle used his radio to alert the company command post to the incident. The injured soldier from the first Iltis was told to prod his way along the roadway to the second group. Soldiers from the second vehicle gradually made their way to the bodies of their two colleagues. They began to attempt resuscitation until a response team arrived. Medical personnel then helped to evacuate the injured. It took several hours before the route was cleared to retrieve the bodies.

Following the incident, attention focussed on the relatively light protection offered by the Iltis. However, the decision to use them was justified because they were equipped with a new Tactical Command, Control and Communications System (TCCCS). More significantly, there were no other vehicles that could be obtained in sufficient numbers within the compressed timelines available to mount International Security Assistance Force (ISAF) operations. ISAF is the NATO-led security mission in Afghanistan responsible for supporting the Afghan Transitional Administration under Hamid Karzai. Modifications were made to the Iltis to improve crew protection. However, they were still condemned as 'totally unsuited' for the role that they were called on to perform around Camp Julien (ref. 8).

In the aftermath of the Jowz valley attack, concerns also focused on the Standard Operating Procedures (SOPs) that were used for proving routes. These had been drafted without reference to the generic Field SOPs (FSOPs) on Mine Clearance and Ordinance Disposal as well as FSOPs on Landmine and Explosive Hazards. These were distributed to force engineers on deployed missions but not more widely. The latter FSOP contained recommendations derived from two previous incidents that were very similar to the Jowz valley attack. This reinforces the concerns raised by the US GAO that military organisations need to improve the dissemination of lessons learned from IED attacks around the globe (ref. 5).

Kandahar, Afghanistan, April 2008

The second incident focuses on an IED attack that led to the deaths of two UK Royal Air Force personnel during April 2008. The similarities between this and the previous case study show that some lessons had still not been learned in the years after the Jowz Valley explosion. At the time of this attack, the soldiers were part of a Quick Reaction Force (QRF) providing security for Kandahar Airfield, Afghanistan (ref. 9). Initially, they were tasked to patrol the West of the airfield. Immediately before departure the unit was split into two groups so that one half could help to move equipment needed by the Afghan National Army to the North East of the base. They crossed a wadi that was recognised as a 'Vulnerable Point' (VP). This route had been used several times in the previous week by other coalition forces. They did not possess a Hand Held Metal Detector (HHMD) but

dismounted to conduct a VP check. This was in contravention of SOPs. They successfully completed the initial crossing and re-joined the rest of the patrol. Shortly afterwards, the unified force conducted a dismounted patrol and then a car pursuit in response to reports of Taliban activity. However, these actions proved fruitless.

The patrol was then notified of a change in runway direction for a departing aircraft. They were, therefore, tasked to patrol the Eastern side of the runway. This provided an opportunity to return to base and have a meal. They retraced their route across the wadi. The lead vehicle assumed responsibility for assessing the risks on their journey back, including C-IED checks. They, therefore, used their Personal Role Radios (PRR) to confirm that VP checks had been conducted on the route out through the wadi. The soldiers in the lead vehicle stopped for approximately 30 seconds to conduct a visual search. They did not dismount. The lead vehicle then proceeded into the water crossing following the usual track. The second vehicle followed them. At this point, other members of the QRF observed people close to the wadi; this was interpreted as a sign that there was unlikely to be enemy activity in the immediate vicinity.

An explosion occurred as the third vehicle attempted to cross the VP. The Land Rover was turned through 180 degrees and ended up around 5 meters from the blast crater. Parts of the vehicle were found a further 200 meters away. The casualties were recovered by their colleagues in the QRF and an evacuation was initiated. A helicopter was used to transport one of the victims. However, the response was hindered by problems with the PRRs. The remaining casualty had to be driven back to the air base. The evacuation was further complicated by the effects of the blast. Several members of the QRF were dazed and disoriented in the immediate aftermath of the explosion. There were also concerns that the forces working to secure the VP would be vulnerable to secondary attacks.

The subsequent investigation determined that the probable cause was the detonation of an Italian TC-6 Anti-Tank mine by the left rear wheel of the Land Rover as it crossed the wadi. Although the area contained a number of legacy Soviet mines, there was little evidence that the explosion was caused by inadvertent migration from nearby minefields. It, therefore, shares similarities to the Jowz valley attack. In both cases, the Boards of Inquiry found that the blasts were the caused by Taliban actions.

In the aftermath of the Kandahar attack, attention focussed on the reasons why the QRF had used the same entry and egress points for the airfield. The UK C-IED tactics also required that HHMDs should be used to safeguard the passage of multiple vehicles through VPs. However, there were insufficient devices at the time of the attack. The Board of Inquiry found that 'had more HHMDs been available and used by the patrol, there is an unquantifiable increased probability that the patrol might have found the device' (ref. 9). The first half of the QRF that initially crossed the wadi did not have an HHMD; their device was with the rest of the formation as a result of the rapid decision to split the patrol. The QRF also lacked guidance on 'Go/No Go' criteria that might have prevented them from splitting the unit when there were insufficient detectors. Higher level discussions about the risks by the Squadron Executive had been informal and were not recorded. In addition, the C-IED training provided to the QRF had not been conducted by the engineering units responsible for drafting SOPs. Hence, the Board felt that troops and their commanders had underestimated the importance of HHMDs for C-IED operations.

Maysaan Province, SE Iraq, February 2007

An attack on a Tactical Landing Zone (TLZ) provides a strong contrast to the two previous IED incidents. This took place in Maysaan Province close to the Iranian border in South Eastern Iraq (ref. 10). The crew of a Hercules C-130 aircraft were ferrying troops to the TLZ. The pilot and co-pilot both had experience of similar operations. The area had been cleared and swept by friendly forces; part of the UK detachment that was being flown in. The preparations included an inspection both of the landing strip and areas on either side of the improvised runway. Communications were established between the aircraft and the Tactical Air Traffic Control (Tac-ATC) officer at the TLZ. The approach was uneventful until an IED detonated as the Hercules flared. The associated flash temporarily blinded the aircrew. This first detonation was followed by a second flash and a louder explosion. The aircraft veered to the left of the runway with a fire on its port side. The Hercules was quickly evacuated with only minor injuries. The aircraft was subsequently destroyed by coalition forces as there was no immediate way to retrieve it.

Another RAF C-130 was in the vicinity. The crew offered to help as soon as they were notified of the incident. However, at this stage it was unclear whether or not it was safe for them to land. The Captain of the damaged C-130 instead borrowed the Tac-ATC officer's radio and requested that information on the incident be relayed

to the command at Basra. The Captain retained the radio and was subsequently told by the C-130 Detachment Commander at Al Udeid to use the second aircraft to evacuate the area. Meanwhile the Tac-ATC officer found that the IED had caused minor damage to the runway. He, therefore, took steps to move the landing area. He also discovered numerous items of wreckage from the Hercules on the runway. He did his best to remove the larger pieces. While he was doing this the crew of the second C-130 had lost communication with the Captain of the damaged aircraft. Nevertheless, they decided to continue with their approach.

By this time, the Combined Air Operations Center (CAOC) had been informed of the incident and was working to coordinate an evacuation of the TLZ. The Chief of Combat Ops instructed the second C-130 not to land. There was a concern that any subsequent landings would be at risk from secondary IEDs. This command was not relayed in time to prevent the second C-130 from landing. At this time, the Tac-ATC was still clearing debris from the runway. He later stated that he had assumed the TLZ was closed, following SOPs. He and his force protection companion just had enough time to evacuate the landing zone as the aircraft's wing passed over their heads. During the landing the Tac-ATC heard the sound of metal striking metal. He did not mention this to the C-130 crew. The second C-130 spent a little more than 30 minutes on the ground before departing with the crew of the first aircraft and the troops that were to be extracted by the original mission. The second C-130 continued operating during the day. It was only on the following morning that the effects of the debris were discovered. A large section of rubber was cut from the port forward main wheel tyre and there was damage to the side walls of both the port aft main wheels and the port nose wheel.

Subsequent examination of the landing zone identified two different explosion sites. The first IED array was marked by two adjacent craters. A second cluster of three craters was also found approximately 70 meters along the landing strip. These sites were linked to an arming position where a hand grenade was also discovered. This was not believed to have formed part of either IED but was intended as a means of self-defence by the insurgent forces who had manned the position. All TLZ missions were suspended throughout the area of operations while investigators tried to mitigate the risks posed by future IED attacks. Permanent force protection teams were created to monitor landing zones around the clock. However, many units struggled to sustain this level of protection.

The subsequent enquiry could not identify any specific pattern being set for the use of the TLZ in the six months prior to the attack. This forms a strong contrast with both the Kandahar VP and the Jowz valley road where enemy forces had opportunities to monitor previous traffic. However, the damaged C-130 had been held for around 45 minutes before making its final approach. A fault was discovered with the original aircraft but part of the delay in changing planes had been made up in flight. In consequence, the crew had to hold for three quarters of an hour in order to synchronise with ground forces at the TLZ. This increased the risks of being observed by insurgents while the C-130 flew a range of tracks, including four passes close to a nearby town. The delays in executing the landing combined with the lack of SOPs for TLZ clearance combined to create the opportunity for IEDs to be deployed. As with previous incidents, the subsequent investigation focused on search methods to detect potential devices. In particular, the Board identified a number of differences between 'generic' C-IED training and the protection of TLZs. Landing strips required a far greater area to be covered than in most other contexts. There was also a requirement to check and re-check TLZs before they were used without alerting the enemy to a potential operation.

Lessons from the Case Studies

The Kandhar and Jowz valley attacks show that similar tactics have been used against the lightly armoured patrol vehicles of different national contingents over a five year period. The Jowz valley attack itself arguably also demonstrated a failure to learn from previous IED incidents in Somalia. It is, therefore, important to understand the 'opportunities' that have been exploited by previous attacks if we are to anticipate future vulnerabilities (ref. 5).

The Need for Specialised Counter IED Training: In all three of the attacks described in this paper, operational pressures had eroded the opportunities for pre-deployment training in C-IED operations. This might have prepared personnel for the challenges posed by their operating environment. In the case of the C-130 loss, it is clear that the Force Protection units did not understand the requirements of TLZ clearance. The lack of training was compounded by inadequate SOPs. There was insufficient guidance on how to prevent insurgent forces from deploying a device between the time that the TLZ had been inspected and any subsequent landings.

Similar findings were reached in the aftermath of the Jowz valley detonation. Canadian patrols had not been trained on the best ways to use the Iltis in counter insurgency operations. The lack of company level training meant that there was a failure to question the use of a "light, unprotected, unarmed and underpowered vehicle ... in operational scenarios during a realistic training event" (ref. 8). In particular, the mobility provided by the Iltis in urban environments was less important in the open areas around Camp Julien where IEDs could be deployed with less chance of observation. The Board of Inquiry also argued that the lack of specific training exercises with the Iltis was compounded by the failure to coordinate a collective, final exercise to support Theatre Mission Specific Training. There were no sustained opportunities to revise SOPs to reflect the operational characteristics of the equipment that was deployed to Kabul. Piecemeal attempts were made to adapt their tactics to the strengths and weaknesses of the vehicles. However, this was not coordinated nor was it consistent across all units.

The Need to Revise Counter IED Risk Assessments: Military personnel failed to accurately assess the threats posed by IED attacks (ref. 7). Canadian forces assessed the Jowz valley road as 'low risk'. The British patrol did not carry out a full C-IED drill on the wadi VP and ground forces did not complete the clearance of the TLZ at Maysaan. The generic guidance provided in existing risk assessment doctrine often did not reflect the operational demands that were being placed upon these units. It was also difficult to obtain copies of the relevant SOPs. In consequence, local practices evolved over time. Individual units had to be repeatedly reminded to use the recognised SOPs. For instance, the Canadian Risk Management Decision Support Template for the Generic Force SOPs stated that "Trafficking a route or a piece of ground using a heavy vehicle or a mine resistant vehicle such as a Nyala or Mamba does not amount to anything. It is not a proofing method. A mine resistant vehicle such as a Nyala is to be utilized for recce and/or casualty extraction only". Local practices did not reflect official views; the Jowz valley road was cleared by driving over it in this manner.

Our three incidents also show that IED risk assessments must be reviewed over time. Changing levels of insurgent activity can increase the threat. Complacency and the establishment of routine behaviours increase the vulnerability to IED attacks. This is illustrated by the way in which TLZs were cleared and then left for short intervals during which enemy forces could plant and activate IED arrays. Similarly, the proving techniques used in the Jowz valley meant that insurgents could observe a sudden intense period of activity on strategic routes as engineers first conducted reconnaissance then proved the route before it was opened. On several occasions the Jowz valley road was assessed as a 'low risk' area. In contrast, the subsequent investigation used information available prior to the attack to argue that it should have been classified as a 'high risk' target "with the clarity of hindsight and within the confines of the sterile Board setting". In the Kandahar attack, the repeated crossing of the wadi created a local vulnerability that arguably should have been the subject of a more sustained risk assessment. The Board of Inquiry argued that that insufficient training in risk mitigation techniques within the C-IED programme combined with perceived operational pressures to create a situation in which the patrol ran the risk of repeated crossings through the vulnerable point without an HHMD inspection (ref. 9).

The Need to Combat Degraded Modes of Operation and A Culture of Routine Equipment Failure: Communications failures exacerbate the problems of coordinating multiple resources and teams in dynamic environments with uncertain threats. For instance, during the Kandahar attack the commander of the lead vehicle asked whether a C-IED drill had been conducted on the wadi prior to the detonation. His recollection was that a confirmation of the mine detection drill was received over the PRR. However, it is clear that this had not been done and that other members of the team knew there had not been a full search. These communication problems were compounded by equipment failures. There were delays in summoning help from the Joint Defence Operations Centre (JDOC) because the radios in one of the vehicles were not working. This, in part, explains why one of the casualties was evacuated by helicopter while another was brought back to the airfield by Land Rover. The flexible way in which soldiers responded both to the incident and to communications problems shows how military personnel learn to cope with degraded modes of operation. The delays in evacuating the victims of the attack did not affect the outcome. However, this incident provides further evidence of the need to continually improve communications infrastructures and coordination in the aftermath of IED attacks.

Degraded communications also affected the Jowz valley blast. There were no medical personnel assigned to the Canadian patrol. In consequence, an urgent request was made for support in the immediate aftermath of the attack. An ambulance was dispatched to the scene, however, the medical team realised that further support would be needed. They then attempted to summon a second ambulance from Camp Julien. This request was delayed because the radio systems were not working. It is surprising that personnel must continue to cope with these degraded modes in spite of the sustained investments that have been made by many armed forces (ref. 7).

Technical problems were compounded by human factors issues during the Maysaan attack. In this incident, the Captain of the first C-130 did not use his own communications equipment after the initial blast. Instead, he borrowed the Tac-ATC's radio. This, in turn, undermined the ATC officer's situation awareness during the approach of the second aircraft. While the Tac-ATC was clearing debris from the runway, the Captain of the first C-130 used his radio to coordinate the evacuation with the second aircraft. However, the crew of this C-130 did not realise that the first Captain was using the ATC radio. They repeatedly tried to contact the Tac-ATC officer and did not know that he was clearing debris from the TLZ. Communication was then lost between the first Captain and the crew of the second C-130. Nevertheless, the crew decided to continue with their landing. This decision is entirely typical of the manner in which well trained and motivated personnel will take direct risks to support their colleagues in the aftermath of an attack. However, they arguably underestimated the potential hazards from secondary devices and from wreckage. The degraded modes that affected communications systems during these three attacks provide important learning opportunities for military organisations. In particular, they help to inform training scenarios. It is essential that personnel do not anticipate perfect communications in the aftermath of an attack. The three case study attacks illustrate the need for suppliers to study previous attacks and understand the practical consequences of functional shortcomings in their equipment. In the past, procurement initiatives have been based around requirements that do not adequately reflect the rigours of the environments in which systems must be deployed and maintained (ref. 7).

The Need to Feed Operational Insights into Acquisition and Planning: The Iltis was vulnerable to the Jowz IED attack; "The Iltis vehicle was not an appropriate platform for a mounted presence, or force patrol protection in that area, at that time" (ref. 8). There was a mismatch between the operational strengths of these vehicles and the nature of the threat that they faced. These criticisms could equally have been raised about the British Land Rovers in Kandahar. Although these vehicles were light and agile, they provided little protection against IED attacks using military grade munitions. However, there were good reasons for using these vehicles at the time. Firstly, they were available in sufficient numbers to support operational requirements. The alternative Light Support Vehicle Wheeled was arguably even less popular amongst Canadian personnel. Secondly, the Land Rover and Iltis had been used in similar roles in other conflicts, for instance in Northern Ireland and in Somalia. Unfortunately, the perceived success of previous deployments may have undermined sustained attempts to identify their potential vulnerabilities to IED attacks in Kandahar and the Jowz valley. In addition, Canadian risk assessments may not have paid adequate attention to previous attacks on peacekeeping operations in Somalia. A further justification for using these vehicles was that they provided specific operational benefits. This illustrates the complex nature of military risk assessment. In this case, the benefits provided by the TCCCS radios, mentioned previously, were perceived to outweigh some of the Iltis' shortcomings.

There are further examples of the mismatch between available equipment and operational requirements. Proving operations at Camp Julien had to be conducted using a Light Armoured Vehicle (LAVIII) rather than a Nyala mine protected personnel carrier, which was usually allocated to this task. The Nyala vehicle afforded additional protection against IED attacks. However, this platform suffered from many of the maintenance and logistic problems that limit specialist 'one of a kind' military vehicles. The Canadian's Nyala had been out of action for some two weeks before the attack while spare parts were delivered to the base. The failure of such mission-critical vehicles goes well beyond the loss of particular functional capabilities. Procedures were drafted to support the use of the Nyala. When the vehicle failed, the operational requirements did not disappear. In consequence, personnel identified 'work arounds'. In such circumstances, the risk based approach that informed the development of military doctrine seldom guides stop-gap measures to address the temporary loss of critical equipment.

The Need to Provide Sufficient Reliable Mine Detection Systems: The shortcomings of the Land Rovers were exacerbated by inadequate training and insufficient HHMDs. These problems were not resolved after the Kandahar attack. The same issues contributed to the deaths of Corporal Sarah Bryant and three SAS soldiers when their vehicle was also destroyed by an IED in Lashkar Gah three months later. Although compromises had to be made when there were few alternative vehicles, it is clear that there were delays in updating both training and SOPs to reflect the threats identified from previous incidents. Without sufficient HHMDs, the alternative visual search techniques were slow, laborious and error prone. These limitations were exacerbated by environments, such as the wadis, where suspect devices could be hidden with relative ease.

In the Jowz valley, Canadian forces might have called upon the ILDS. However, this continued to suffer from significant technical problems. The ILDS required several dedicated operators. The complexity of the system meant that there were too few maintenance technicians who were qualified to support it. Staffing constraints were exacerbated by the need to cut the numbers of available engineers so that they could be redistributed to

meet changing strategic requirements. These limitations continue to prevent the deployment of advanced mine detection technologies. However, they have not dissuaded suppliers from offering more and more complex devices that cannot easily cross the divide between the laboratory bench and operational environments.

The Need to Develop Team Resource Management Expertise: Personal initiative and bravery were reinforced by pre-deployment training in the immediate aftermath of these attacks. Soldiers worked around a host of communications problems and equipment failures. However, many individuals also struggled to overcome the effects of shock. Personnel were stunned after the detonation in Kandahar. Their personal radios did not work and it was hard to coordinate their response; to coordinate support and to assist the survivors. It is fortunate that these problems were not compounded by secondary attacks. The vehicles deployed by the extraction and evacuation teams were just as vulnerable as those in the initial patrols.

Similar pressures affected the crew of the first C-130 when their aircraft landed in flames. The urgency of the evacuation is illustrated by the non-standard use of the intercom to announce 'right we're getting out' without using backup bells, a public address (PA) announcement. Although this did not exacerbate the consequences of the attack, other crews might not be so fortunate in the future. Four out of the six in the crew lost intercom connections because their cords had become snagged or entangled. One of the leads was severed. The psychological 'performance shaping factors' that characterised the crews actions in the immediate aftermath of the TLZ blast were compounded by uncertainty and confusion about the nature of the attack that they had sustained. The Captain did not use their tactical communications system to alert the Combat Search and Rescue (CSAR) teams of the need for potential extraction; "As a result a fully coordinated CSAR response ... was not forthcoming, effectively isolating the controlling authority who could have stopped and indeed did try to stop the 2nd C-130 from landing".

Team Resource Management (TRM) training has been introduced as a compulsory requirement across many civilian industries. This provides explicit insights into the human factors problems that complicate decision making under uncertainty. It also provides experience in coordinating communications across multiple teams in the aftermath of equipment failure. Much of this training initially borrowed ideas from the military. However, many recent developments in civil TRM training might now inform C-IED exercises. For example, in commercial aviation the focus has moved away from annual simulations of catastrophic events to more regular practice in the everyday behaviours of monitoring and cross-checking that will also help aircrews respond to high consequence, low probability incidents. Some aspects of this training are similar to the everyday risk assessment techniques that have been introduced as part of the US Army's Composite Risk Management initiatives.

In all three cases, operational pressures limited the opportunities for personnel to rehearse their response to potential attacks. In consequence, many of those involved were either unfamiliar with SOPs or felt that they were not applicable in the minutes after the detonations. Without appropriate training exercises that not only consider the detection of IEDs but also the coordinated response to blasts there is a significant risk to future operations, especially from secondary attacks.

Conclusions

IEDs remain one of the most significant threats to conventional military forces around the globe. Unfortunately, the response to previous attacks has often been uncoordinated and incoherent. Some nations have issued urgent operational requirements to invest in new, more resilient vehicles. Others have developed upgrades to existing platforms. Undue haste has resulted in unsuitable modifications and piecemeal improvements that provide limited protection at great financial cost. New acquisitions are often delayed by unwieldy procurement processes. In both situations, troops are often forced to continue using the original, unsuitable and vulnerable vehicles. Not only does this expose them to IED attacks but it also has a devastating impact on morale. Some nations have responded to the threat posed from IEDs by developing 'leading edge' detection or jamming technologies. Unfortunately, these seldom meet the expectations of their proponents. They are too complex, unreliable, and difficult to maintain in the field. They often trigger unacceptable numbers of false alarms or fail to identify a significant number of IEDs. Other forces have responded to similar incidents by revising SOPs using C-IED risk assessment techniques. However, personnel often do not understand how to apply this doctrine. Operational pressures also prevent soldiers from reassessing the risks posed by IED attacks when there are changes in insurgent tactics or when new vulnerabilities might emerge over time, for instance as a result of increasing levels of complacency. Further problems arise when troops also have to cope with communications failures and with the shock that undermines effective responses to IED attacks.

The limitations of existing C-IED initiatives make it important that we learn as much as possible from previous attacks. This paper has identified common factors across three very different IED incidents, including two blasts directed at light vehicles operated by Canadian forces in the Jowz valley and the British in Kandahar. The third case study focused on a TLZ attack in Maysaan Province, Iraq. A number of detailed lessons were identified:

1. There is a need to ensure that operational pressures do not undermine the provision of specialised C-IED training both before and after deployment. It is also important to innovate if we are to significantly improve exiting course; for instance by exploiting similarities between the US Army's Composite Risk Management initiative and civilian Advanced TRM training.

2. It is important to ensure that all C-IED risk assessments are revised on a regular basis to ensure that they reflect changing local threat levels and the possibility that complacency increases the vulnerability to future attacks.

3. The acceptance of 'degraded modes of operation' needs to be challenged; too often personnel are trained to cope with routine equipment failures during IED attacks that are symptomatic of wider failures in the supply chain.

4. Previous IED attacks reveal the need to review acquisition and procurement practices when the dangers of piecemeal improvements to unsuitable vehicles or communications infrastructures are not reflected in SOPs and C-IED risk assessments.

5. There is a need to provide sufficient numbers of reliable mine detection equipment, especially when more advanced technologies have failed to provide the anticipated benefits. Training in the use of these devices must be updated as insurgent forces adapt their tactics in the field. Where this cannot be ensured, troops must accept that it is not possible to detect a potential attack before it occurs.

Much work remains to be done. Previous sections have argued that we need specialist investigators to identify lessons from previous IED attacks. This would provide greater levels of consistency and assurance in the recommendations from Boards of Inquiry. At present, many investigators are explosive specialists with little explicit training in incident investigation; this explains why similar attacks have yielded such different recommendations. One Board of Enquiry noted that many of the individuals involved in these investigations may be "unqualified to produce post blast investigations and reports" (ref. 8). In contrast, a range of formal investigation techniques might be extended from the analysis of civil incidents and accidents. These could include 'resilience engineering'; rather than focus on the problems that have complicated C-IED operations, future research might instead focus on the success factors that have helped to reduce the threat in some areas of Iraq and Afghanistan. Further operational studies are required to identify those SOPs and technologies that contributed most to the detection of devices. It is also important to understand why some units have proven to be more 'resilient' in the aftermath of an attack (ref. 7).

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