# The use of military planning techniques to manage outbreaks of novel infections in acute inpatient settings: development of an 'Infection Control Estimate' (ICE).

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| Abstract: | Outbreaks of infection create unique challenges to healthcare leaders and members of infection control teams who lead efforts to manage, control and resolve outbreaks. This is especially true during outbreaks of novel pathogens which may require atypical control methods reflecting the unknowns inherent in such situations. Healthcare providers within the UK have adopted various structures and models of infection prevention and control service reflecting the individual needs of different organisations. As such, the roles and responsibilities of IPC practitioners vary between organisations. Variations in models of care combined with challenges created by outbreaks of novel infections may make algorithm-based approaches to outbreak management less effective and potentially prone to missing key actions or considerations which may improve outcomes. Here we suggest the application of a widely established military planning technique, developed to aid decision making in combat environments, to the management of outbreaks of novel infection in acute hospital settings. The technique can be applied at all levels within an IPC hierarchy regardless of role or responsibility and may improve the coherency and efficacy of outbreak management efforts made by IPC teams. The technique may also be applied to outbreaks of known infections however, in order to demonstrate the flexibility of the model novel infection has been used to illustrate its potential value in outbreak management when knowledge is limited. |
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Table 1: The Combat Estimate and the Infection Control Estimate (ICE)

| Combat Estimate | Infection Control Estimate |
|---|---|
| 1) What are the enemy doing and why? | What is the nature, distribution and mode of transmission of the organism? |
| 2) What have I been told to do and why? | What is the objective/why do I need to control this organism? |
| 3) What actions/effects do I want to have on the enemy and why? | How can I reduce the risk of onward transmission / limit impact to patients? |
| 4) Where can I best accomplish each action/effect? | Where and when will each of my control actions be most effective? |
| 5) What resources do I need to accomplish each action/effect? | What resources will I require to achieve my aims and who will be most effective in delivering these? |
| 6) When and where do these actions take place in relation to each other? | In what order will I perform my control plan and where will be best to focus efforts for maximum impact? |
| 7) What control measures do I need to impose? | What are the interventions/ what post-action evaluation do I need to impose to determine if my plan was effective? |

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## Introduction:

Infection prevention and control is a fundamental responsibility and legal obligation of modern healthcare Health and Social Care Act (2012). When infection is not controlled, transmission events become more frequent which may lead to an outbreak being declared. This can lead to epidemics and pandemics. Outbreaks challenge already struggling infrastructures and require specialist input and optimum management (Kambhampati et al 2015). At an organisational level, outbreaks have the potential to cause significant financial and human cost (Otter et al 2016). The impact of epidemics has created significant changes socially and politically. Routine processes, including food preparation and air travel, now require stringent policies to mitigate risks associated with infection (Woc-Colburn and Hotchandani 2020). Notably, the risk of outbreaks of re-emerging and novel infection has increased over time due to the effects of globalisation, urbanisation and antimicrobial resistance. This indicates an ever-growing need for an adaptable and dynamic approach to outbreak management (Bloom and Cadarette 2019).

A recent outbreak of a novel coronavirus in Wuhan City, in the Hubei province of China (SARS-CoV-2) has highlighted key challenges associated with outbreak management in contemporary healthcare (Peeri et al 2020). Cases of novel infections may present challenges due to traditional reactive approaches adopted by Infection prevention and control services, challenging communication issues and underpowered infection control systems. This is demonstrated by high numbers of infected healthcare workers observed and the rapid spread of novel infections (Peeri et al 2020). Unlike historical epidemics, modern infection outbreaks are often accompanied by the sharing of misinformation on the internet, leading to a potential 'infodemic'. As a result, certain groups may face stigmatisation and in extreme cases may lead to deviation from international health regulations (Horton 2020, Habibi et al 2020). As such, clear, effective planning and communication is key for infection control teams when dealing with novel pathogens. It would be desirable for teams to recognise when a dynamic approach is required, being able to make changes as knowledge and understanding grows. The management of outbreaks in acute settings has established processes including the identification and declaration of an outbreak, determination of a case-definition, active case finding, hypotheses testing, implementation of controls and the

creation of an outbreak report (Houlihan and Whitworth 2019). Although advances have been made in areas such as surveillance methodology and diagnostic testing which underlie traditional outbreak management processes, there remains little literature describing the formulation of control plans by infection control teams or proposing novel strategies. A scoping study by Hale et al (2015) investigated IPCT practices in the United Kingdom and reported that teams often adopt a 'fire-fighting' approach. This allows little time to balance outbreak management with routine IPC issues or understand the impact of this as a model of practice. At a national level, guidance on the control of communicable disease outbreaks from Public Health England (PHE) (2014), suggests considerations for outbreak control plans. However, no systematic process for generating plans that relate to control measures is proposed. Efforts made at both a local and national level may benefit from a consistent and structured approach during the formulation of outbreak control plans.

## The Seven Questions

The seven questions or 'combat estimate' is a problem-solving tool used by the British military. Its aim is to produce 'an adequate and flexible plan in a reasonable amount of time' (Ministry of Defence 2010). Initially intended for use in combat situations, the seven questions format is tested, easy to follow and allows the rapid identification of important issues. It focusses attention when cognitive demands are high and allows the user to produce a complete and effective plan for a given situation. The paradigm thus lends itself well to rapidly evolving situations, such as outbreak management of novel pathogens. Borrowing established processes from other sectors is not uncommon. In 2007, Catchpole et al adapted Formula 1 racing and aviation tools to communicate patient information from surgery to intensive care. Similarly, Johan et al. (2006) used Statistical Process Charts (SPC) from industrial manufacturing in the surveillance of healthcare acquired infection (HCAI).

The seven questions follow a logical pattern. In the first instance they address the nature of the situation, followed by the development of course(s) of action. In doing this they highlight areas where contingencies or further information may be required. Non-military applications of the seven questions paradigms have already been described in business and surgical planning (Wood et al 2014, Shama 2016). The seven questions and proposed infection control corollary are shown in Table 1.

This article will present a proposed application of the seven questions for infection control planning in the context of a novel infection outbreak in the acute care setting. It is important to note that this model could be adapted for all levels of management. This is achieved by answering the proposed questions in a manner relevant to the level of managerial responsibility of the individual(s) completing the process.

**Question 1:**

What are the enemy doing and why? – Combat Estimate (CE) /What is the nature, distribution and mechanism of transmission of the organism? – Infection Control Estimate (ICE)

Understanding the causative organism or agent, its natural history, epidemiology and crucially its mode(s) of transmission are key to limiting spread and managing an outbreak (Cowling and Leung 2020). Consideration of this question will inform IPC risk assessments by identifying the requirements for Personal Protective Equipment (PPE), isolation and cleaning/decontamination. These control methods may cause significant disruption to patient flow, reduce bed capacity, impact service provision and have cost implications so it is essential that they are measured and well considered.

Within the military setting, a Request for Information (RFI) can be made by Commanders at any level. This is used to ensure that sufficient information is available at the level required for achieving the assigned tasks. Military commanders are encouraged to utilise RFI in order to ensure not only that plans are complete, but that effective two-way communication exists within the command hierarchy. In the civilian IPC context this may involve liaising with specialist professionals or external organisations and cascading information suitable for the various teams involved in the response, with an appropriate level of detail. The ability to use RFI also mitigates the risk of 'information overload' during initial briefings which may detract from key issues which require focussed planning, whilst ensuring opportunity to clarify key issues prior to making plans.

At an acute hospital level, consideration should be given to:

- Further information (RFI) sought from organisations such as the World Health Organisation (WHO) or Public Health England (PHE) or from specialists including Microbiologists/Virologists and Pharmacists to help determine the clinical relevance of information which may impact infection control methods.
- Analysis of available local data (syndromic surveillance, laboratory data, demographic data to determine risk factors)
- Determining a case definition for proactive surveillance to monitor outbreak progression/determine the impact of any interventions implemented

**Question 2:**

What have I been told to do and why? (CE) What is the objective/why do I need to control this organism? (ICE)

Understanding the intent and mission of a commander's 'one-up' (one rank above) and 'two-up' (two ranks up) is critical to providing context to military planning and may have relevance in a civilian context. It has been proposed that contrary to the hierarchical nature of healthcare, flatter leadership gradients facilitate communication, shared decision making and may improve outcomes (Green et al 2017). A clear understanding of the intentions and aims of an individual's immediate line management will ultimately help produce more coherent planning and encourage consistency in approach within a clinical team. This is especially true for IPC practitioners who may be called upon to coordinate the planning and delivery of an element of a larger overall strategy, for example the delivery of training on specific topics or coordination of creating cohort areas. By addressing this question, in combination with an understanding of the aims and intentions of an individual's line management, plans may be more focussed and in-keeping with the overall commander (or managers') aims.

In order to answer this question, infection control teams, need to consider what the implications of an outbreak may be: will the outbreak lead to acute illness, or colonisation with only the potential for clinical sequelae? What are the long-term implications of infection/colonisation? Are there effective treatments available/decolonisation therapies? Will certain patient cohorts be affected more than others? Consideration of these points may allow efforts and resources to be directed more wisely. In cases of novel pathogens, the societal, political and clinical impacts of the organism may contribute towards more cautious decision-making regarding management and control strategies. Notably, the impact of the recent SARS-2 CoV pandemic led to the implementation of extreme control measures by the British Government including social distancing, shielding of vulnerable groups and the closing of schools and businesses. Many acute care providers restructured their models of care, in order to prevent overwhelming the national health service (Anderson et al 2020). The impact of control measures used during the SARS-2 CoV pandemic is yet to be determined.

**Question 3:**

What actions/effects do I want to have on the enemy? (CE) / How can I reduce the risk of onward transmission/limit impact to patients? (ICE)

Understanding the epidemiology and pathology associated with a pathogen will ultimately guide the expectations of clinicians and policy makers on how they can reduce risk. This question encourages careful consideration of what impact is desired. This may be to prevent transmission entirely to reduce transmission to a manageable level. During the SARS-2 CoV outbreak, the British Government adopted a four-phase strategy: contain, delay, research and mitigate. This strategy was designed to reflect the changing epidemiology and focus of infection control measures during a pandemic (DoH, 2020). The phases were clearly described with the aims of each phase defined in detail. This guided the actions and plans made by individual healthcare facilities ensuring that they were aligned with national aims.

A clear objective and detailed desired outcomes are essential in order to determine the best approach for success. The most desirable outcome would be total eradication of the pathogen/agent, but this is not always practical or possible. More realistic goals could include reducing environmental burden through removal of known reservoirs (Decraene et al 2018), to reduce exposure, or through vaccination to reduce susceptible groups (Pegorie et al 2014). More recently, social distancing and self-isolation has been employed to reduce/delay transmission as with SARS-2 CoV.

Optimisation of risk requires consideration of the interventions and resources available. This may include:

- Isolation of patients
- Use of specific infection control precautions
- Screening programmes and contact tracing
- Delivery of targeted training to healthcare professionals

**Question 4:**

Where can I best accomplish each action/effect? (CE) / Where and when will each of my control actions be most effective? (ICE)

Outbreaks in acute hospital settings may create anxiety and concern amongst staff (Chen et al 2020). Clear timelines that define and indicate when actions are to take place may mitigate this. For example, if the control plan includes fit testing staff for respirators, delivering training on PPE or closure of clinical services, these actions need to be communicated in a timely and effective manner. This will ensure staff morale and safety is maintained and the effectiveness of clinical care is prioritised.

During the SARS-CoV 2 pandemic, staff in the UK felt that they were denied timely access to appropriate PPE (Campbell and Busby 2020). Infection control teams can potentially mitigate anxiety caused by national issues such as PPE shortages by maintaining transparency during the planning process. Staff should be provided with a clear rationale for every decision that affects them and given advice on how to proceed when conditions are less than favourable. Resources and efforts may need to be prioritised in times of crisis. In less pressing times, more consideration can be given to the most effective and appropriate time and location for maximum impact of interventions and control strategies. For example, screening for Methicillin-Resistant *Staphylococcus aureus* (MRSA) to limit the risk of surgical site infections (Kaplan et al 2019).

**Question 5:**

What resources do I need to accomplish each action/effect? (CE) / What resources will I require to achieve my aims and who will be most effective in delivering these? (ICE)

Management of outbreaks often requires resources in quantities or from sources that are not used under normal circumstances. This may require:

- Additional laboratory facilities or equipment
- Additional staff or redeployment of staff
- Supplies of PPE
- Restructuring of clinical areas to accommodate affected patients
- Pharmaceuticals (Medication/vaccinations)

Consideration of what resources are, or may be, required will allow more effective planning and will improve the flexibility of services responding to outbreaks. Actioning this question requires leadership and the ability to work in a multidisciplinary team to effect change across various departments and specialisms.

**Question 6:**

When and where do these actions take place in relation to each other? (CE) / In what order will I perform my control plan? (ICE)

The penultimate question requires the generation of a coherent plan incorporating actions identified via consideration of the previous questions. The time available for planning in early stages of an outbreak may be sufficiently long to allow the main elements of management strategy to be determined and actioned. Once the number of cases increases, consideration of finer details and troubleshooting may be required. However, hospitals experiencing high numbers of cases may require more rapid and dynamic planning to allow more immediate, and potentially more intense control strategies to be implemented. Contingency plans should also be considered at this stage. Whilst a best course of action (COA) is preferable, the situation may require a less favourable plan. Notably, during the SARS-2 CoV pandemic advice relating to the use and reuse of PPE was adapted from what may be considered 'best practice' in order to account for significant shortages nationally (PHE 2020).

**Question 7:**

What control measures do I need to impose? (CE) / What are the interventions and what post-action evaluation do I need to impose to determine if my plan was effective? (ICE)

The final question necessitates deciding on the best course of action and most effective strategy, sharing the action plan and assigning tasks including setting deadlines for implementation.

Evaluation of any intervention is essential to preserve resources and ensure efficacy. Documented on-going and final evaluations will allow a post-outbreak review to determine if all precautions and actions were measured and effective.

In outbreaks of novel pathogens evaluation of IPC plans should involve:

- Constant review of new guidance and scientific evidence.
- Encouraging feedback from clinical staff to determine if guidance and interventions are clinically practical or in need of review.
- Observational audits of practice to ensure compliance with control interventions

**Conclusion:**

The management of outbreaks in acute hospital settings presents challenges to key decision makers, including infection control teams, regarding the best and most measured course of action to take. Recent outbreaks of novel infections have taught us that the key to successful management is coordination, dynamic decision making and continuous evaluation of evidence and strategy. Consideration of the principle questions underlying the combat estimate as part of an 'infection control estimate' may help produce more complete and effective plans. The flexibility and simplicity of the 7 questions system has proven its utility in dynamic combat situations, it may therefore have utility in similarly chaotic hospital outbreaks where decision making is often restricted by time and critical to outcomes.

The infection control estimate allows the user(s) to develop a rationalised overview of the infectious threat. This can indicate where resources are best used, where there are gaps in knowledge and the need for contingencies. As it is embedded within the military at all levels, the 7 questions concept can be adapted for healthcare staff of all grades with various levels of responsibility within a management structure. The output of the questions simply reflects the responsibilities and powers of the individual. Application of the ICE may contribute towards greater consistency in practice between IPCT and allow more robust evaluations of efficacy for different outbreak control methods.

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