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Integrating electronic medical records to improve antimicrobial stewardship at the Montpellier Hospital in France

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Improvements in the optimal use of antibiotics is the cornerstone of the French national point-of-care alert for antibiotics (2011–2016). Integrated electronic medical records for antibiotic prescriptions have been deployed in the Montpellier University Hospital (2,800 beds) since 2012. The present paper proposes an overview of integrated electronic medical records for antibiotic prescriptions and how telecounselling at the Montpellier Hospital fits with the global anti-infection ICT strategy. This management change is fully traceable. A review of the results of the project has led to an improvement in patient care via a collaboration between IDS and other hospital members. This project is part of the Region Reference site of the European Innovation Partnership on Active and Healthy Ageing (MACVIA-LR).

Improving the optimal use of antibiotics is the cornerstone of the French national point-of-care alert for antibiotics (2011–2016 (1)). It is based on care pathways and the development of ICT tools for the diagnosis of infectious diseases and the prescription of antibiotics. The alert is aimed at reducing the overall prescription of antibiotics which is still very high in France in comparison to other European countries.

Integrated electronic medical records for antibiotic prescriptions have been deployed in the Montpellier University Hospital (2,800 beds) since 2012. The present paper proposes an overview of integrated electronic medical records for antibiotic prescriptions and how telecounselling at the Montpellier Hospital fits with the global anti-infection ICT strategy.

Medical context

Multidrug-resistant bacteria are becoming more common and, due to their multiplicity of mechanisms, they are frequently resistant to many, if not all, of the current antibiotics. This has become a global health problem and is increasing in prevalence and severity. Antibiotic resistance can be reduced by using antibiotics following the guidelines of antimicrobial stewardship programmes (ASPs). All major resistance-control strategies recommend

education for patients, children (e.g., through schools and day care), the public and relevant health care professionals (e.g., physicians, other health care professionals and medical students) on the unique features of bacterial infections and antibiotics as well as prudent antibiotic prescribing (2). In the early 2000s, over 100 million antibiotic prescriptions were being written each year in France; 80% of these outside hospital care.

Multidisciplinary care pathways for anti-infection treatments

Since 1974, combined with an effective infection control programme, ASPs has been used to help antibiotic prescription in hospital settings by optimizing antibiotic use through expert advice (3). Later, in France, at the end of the 1990s, the recognition of nosocomial infections led to multidisciplinary strategies for their treatment and prevention in ICU and hospital settings (4, 5). These measures were shown to decrease antimicrobial expenditures and improve susceptibilities to antibiotics without compromising patient outcomes or length of hospital stay (6, 7).

In 2008, the French Haute Autorité de Santé (HAS) (National Health Agency) recommended that multidisciplinary (health care and social care workers, managers, etc) care pathways should be implemented for antibiotic therapy coordinated by an infectious disease specialist (IDS). Treatment of infections is however a team operation, using the coordinated expertise of many different medical care professionals. The government plan to preserve the efficacy of antibiotics (2005–2006) has evolved a point-of-care alert for antibiotics (2011–2016 (1)) to improve the prescription of antibiotic therapy. This alert insists on the need to improve prescribing rules and to deploy care pathways using diagnosis and treatment aids including ICT tools to all physicians prescribing antibiotics, especially in private medicine. The action plan requires multiple actions which have already been started. A network is being established to include all stakeholders. A thorough evaluation of the plan has been initiated.

Electronic care pathways

Several studies have shown that point-of-care access to current medical information is easily available to the practitioner using ICT through smartphones, iPads and other personal digital assistants (8, 9), websites (10) or telemedicine (11). The explosion of medical applications (apps) has made it increasingly difficult to find relevant and reliable infectious diseases apps (12). Moreover, the application of a generic recommendation to a specific case may be difficult. In three hospitals in southern France, there was surprisingly no clear link between applying national recommendations for antibiotic prescription and the optimization of hospital organization or the quality of antibiotic prescriptions (13). Electronic care pathways in infectious diseases are usually difficult to replicate in many populations due to diverse factors including local prescribing habits and bacterial ecology (14). A team in Strasbourg, France, has made computerized practice guidelines accessible to physicians when making clinical decisions to improve prescribing practices. The increased availability of antibiotic guidelines at the time of drug ordering, combined with periodic educational reinforcement, has been associated with enhanced physician adherence to these guidelines (15).

The success of these electronic care pathways depends on several factors:

- The clinical situation should correspond to a care pathway already described.
- Care pathways differ depending on local factors and the settings in which the treatment is to be performed.
- Care pathways should be user friendly and the algorithms not too complex.
- ICT integration should minimize the time-to-decision and allow easy management of the individual patient.

Computerized decision support

Computerized decision support (CDS) is the most advanced form of clinical decision support available and has evolved with innovative technologies to provide meaningful assistance to

medical professionals. Practice guidelines implemented through CDS support were implemented in 1985 in Salt Lake City, United States, leaving the final choice to the prescribing physician. The clinical and financial outcomes of these practices were assessed over a period of seven years. Although there was an increase in the number of treated patients (+21.3%), antibiotic use was improved, costs per treated patient (adjusted for inflation) decreased from US\$ 122.66 per patient in 1988 to US\$ 51.90 per patient in 1994 and the emergence of antibiotic-resistant pathogens stabilized (16).

Since 2000, an evaluation of the clinical effects of health information technology has been carried out for infectious diseases. Electronic prescribing has been shown to reduce prescribing errors in hospitals. Computerized decision support systems have been used to help ensure safe medication prescribing. However, the acceptance of these types of decision support has been reported to be low. They have improved the quality of prescribing by reducing both prescribing errors and pharmacists' clinical interventions (17-19). Computerized physician order entry (CPOE) systems reduce the medical error rates. Prescribing errors in terms of drug allergy, drug interaction and drug dosing errors are reduced if the CPOE system is not error-prone and is easy to use, if the user interface is consistent, and if it provides quality information to doctors (20). However, the use of a CPOE system is insufficient if the following factors are not considered: the correct indication, the choice of antibiotic spectrum, a stepwise strategy and regular follow-up of the treatment.

There are limitations to CDS tools:

- They are used by a series of health care professionals who may not be present in the different settings where they should be applied.
- No IDS may be present in the setting.
- They may be too complex for ICT technicians in many settings.
- They are not universally applicable to the local setting or to the individual patient.

Informal IDS consultations for individual patients

IDS-based advice to other physicians is common in most hospitals. However, this requires a considerable expenditure of time by the infectious disease service. The consultation may also involve the exchange of inaccurate or insufficient information between physicians and the infectious disease service, and is not always followed by an appropriate antibiotic prescription (21). A 5-year study in Israel of 14,005 specialist consultations showed that expenditure on antimicrobials per admission had steadily decreased, from US\$ 44 in 1995 to US\$ 30 in 1999: a 35% reduction. In conclusion, the analysis of data from IDS consultations enables the infectious disease service to evaluate its activity and to direct efforts towards departments with high rates of nosocomial infections, antimicrobial resistance and/or antimicrobial use (22). In Nice, France, the implementation of an antibacterial and antifungal stewardship programme was feasible, sustainable, well accepted and cost-effective: IDS were able to consult in different hospital wards (1999), specific prescription of antimicrobials (2005), electronic traceability of the advice and prescription formularies in the electronic patient files (2007), pharmacist alerts which can lead to IDS advice (2007), laboratory alerts (2009), and automated extraction of patient files in the form of a table (2011) (23). However, an appropriate budget is still lacking as well as the integration of care pathways into an electronic format in patient files.

In Grenoble, France, in 2011, compliance with recommendations proposed by informal IDS consultations was found to be comparable to formal consultations (88%) without compromising patient safety. Further study is needed to refine the criteria for requesting or providing informal rather than formal consultations (24). On the other hand, IDS consultations may decrease the efforts of clinicians to follow care pathways and educate patients. A 15-year ASP policy in the Nancy Teaching Hospital assessed the impact of reinforcing this policy on antibiotic consumption. Between 2005 and 2008, the overall annual cost of antibiotics dropped by 34% (25).

However, one problem is paying for the time spent by the IDS, as the benefit for the hospital is not yet clear. Moreover, indicators of cost-effectiveness also need to be accepted

by payers.

Multidisciplinary antibacterial control programmes

A multidisciplinary approach is often needed for complex infections. This includes the IDS, the physician, the hospital team, the pharmacist, the microbiology laboratory and other health and social care workers.

In Oklahoma, the clinical outcomes and cost-effectiveness of an antimicrobial control programme (ACP) were studied. An ACP directed by a clinical pharmacist trained in infectious diseases was associated with improvements in inpatient length of stay as well as mortality. The ACP decreased intravenous antimicrobial costs and facilitated the approval process for restricted and nonformulary antimicrobial agents (26). However, there is a lack of information concerning the duration of isolation times required to decrease cross-transmission, the duration of antibiotherapy, mortality and costs.

In-hospital antimicrobial approval policies are designed to curb the indiscriminate use of antimicrobials. These policies usually require written forms and/or direct requests to an IDS (or surrogate) prior to the release of antimicrobials. One study attempted to measure the impact on antibiotic use of a computer-generated alert prompting post-prescription review and direct counselling in hospital wards. The computer-prompted post-prescription review led physicians to modify half of the antibiotic courses initially prescribed and was well accepted by the majority, although they had not requested counselling (27). The same group studied the unsolicited and systematic evaluation of positive blood cultures after a laboratory report by a single IDS using a computer-generated alert from the laboratory. The impact of IDS counselling was more effective when the evaluation was restricted to medical and surgical wards (28). In some places, IDS advice was requested for all patients, but this led to a delay in the prescription of antibiotics (29).

The multidisciplinary approach appears to be cost-effective and reduces antibiotic resistance. Antimicrobial therapy for 428 episodes of *Staphylococcus aureus* bacteremia in an 850-bed university hospital was prospectively evaluated for one year to measure the impact of two factors – blood culture results and the therapy chosen by the IDS – on quality of treatment and outcome. Empirical treatment was appropriate in 63% of episodes. This proportion reached 78% for episodes treated by an IDS. After the availability of blood culture results, the proportion of appropriate treatments increased to 94%, with 97% for IDS-treated patients and 89% for other patients. The IDS more frequently shifted to oral antibiotics and used fewer broad-spectrum drugs (30, 31).

Patients' electronic files will allow more systematic approaches. However, data from community ASPs are limited. In Taiwan, clinical and economic outcomes from the first year of hospital ASPs (510 antimicrobial orders) were reviewed. Sixty-three per cent were appropriate, 18% prompted de-escalation, 12 were denied, and 5% led to formal consultation with an IDS. The antimicrobial budget decreased by 15.2% and there was a 25.4% decrease in defined daily doses of the target antimicrobials (32).

Factors improving adherence to CDS and ASP

Real-time CDS and complete traceability (drug and care administration with their respective documentation) are essential in terms of medical approach and patient safety. The effectiveness of an IDS consultation is dependent on adherence to the recommendations. To delineate the factors that affect adherence, a prospective cohort study of 465 consultations evaluated multiple factors. Adherence to IDS recommendations was higher when the recommendations were therapeutic instead of diagnostic, when they related to a specific clinical question, when recommendations were deemed crucial by the infectious disease service and if the consultation note was legible and organized (33). Adherence to IDS consultations was around 40% in the early 2000s (34) and is now up to 91% in some recent studies (10, 35).

Telephone services can provide information and support for APS. It was thought that telephone counselling might be less effective than formal consultation and IDS consultation

(22, 36) but its impact still requires further studies (24).

ASP implementation in the Montpellier University Hospital

3-1- DXCare® and IPSoins®

APS uses DXCare® (MedaSys and Orange business service, <http://www.orange-business.com>), the hospital information system used by all members of the Montpellier University Hospital (37). A wide variety of information is managed, and exceptional data collection and record acquisition is provided by IPSoins® which is outstanding for the quality and diversity of the information that it manages. IPSoins® provides hospital health care professionals with one single tool that can be used for all the information it handles: letters, administrative information, requests for/results of tests and imaging, specialist medical files, vocal recordings, databases, etc. Within the framework of research, innovative algorithms and statistical models are being developed, tested and put on the market. The aim is to explore large amounts of information that are heterogeneous and diverse but combined, in order to search for the CDS.

In its standard catalogue, IPSoins® aspires to provide a large number of “career” modules including medical, surgical and psychiatric specialities, obstetrics and follow-up care. In case of missing elements, uncertainties or specific needs such as the management of a clinical study, an extension module using questionnaires is available. This enables the possibility of qualitative management of diseases.

Constructed using ICT, IPSoins® is secure and readily accessible to the other actors involved in the follow-up of patients. Through telemedicine, it is possible for private health care professionals to access part of the medical file from a distance when following up on patients. Such is the case for private doctors and for professionals from the medicosocial sector. This access is highly secure and already possible from sites outside of the Montpellier University Hospital. A very finely-tuned, specific and precise management mechanism allows the administration of rights satisfying the statutory and legal regulations regarding access to patient data.

Application of DXCare® and IPSoins® to ASP

The capabilities of DXCare® were used to build ASP using existing care pathways recommended in France. These pathways were discussed by a multidisciplinary team and adapted to most circumstances (patient type, hospitalized patient, telemedicine or telecounselling). These pathways make it possible to propose a large variety of management systems.

When requested by any physician from the hospital, an IDS initiates the ASP. A personalized file, provided by one of the five IDS, is then available for each patient and immediately embedded in the patient file stored in DXCare®. It is therefore available for all carers in the hospital depending on their access code. If needed, the file is reviewed at a once-a-week multidisciplinary consultation. A specific code allows automatic planning before each multidisciplinary meeting. In parallel, a business objective allows the different clinical events and examinations (indexing clinical situations, by pathogen and according to a pre-established comorbidity list) to be followed.

Demographic characteristics of patients enrolled in ASP

A prospective study was carried out between 1 February and 30 October 2013 of all patients enrolled in ASP. Collected data included clinical and biological data at baseline and follow-up during hospitalization after three and five days. Moreover, the follow-up of the patient after discharge was checked.

The files of 870 patients, and 1386 telecounselling consultations led to a management plan immediately embedded in the DXCare® file (mean patient reviewed per day per IUDS: 5.3). Around half of the telephone calls led to an ASP file. In 18.9% of cases, the file was reviewed by the multidisciplinary team. During the initial IDS consultation, 88%

of cases were solved without a direct visit to the patient, 26.5% of patients had another evaluation and 8% had more than three. Hospitalized patients were in 46 different wards of the Montpellier University Hospital: 42% came from surgery and 17% from orthopaedics. The antibacterial strategy contained 798 completed files with a reduction of treatment proposed in 25.3% of cases, a discontinuation of treatment in 5.1% and a change in therapy in 2.8%.

Adherence to the management strategy was evaluated in 675 patients. Complete adherence was observed for 86.7% of patients for therapy counselling and 76.9% for diagnosis counselling. Recommendations following the multidisciplinary consultation were followed in 89% of cases. When available, an improvement of biological parameters was assessed between three and five days: CRP decreased in 74% cases, peripheral blood leukocytes in 60%, and fever in 42%. Forty-seven point one per cent of patients were discharged at home and mortality was 6.1%.

Consequences and perspectives

Analysis of the files once every three months allowed us to select topics for monthly bibliographic meetings and to perform CME activities targeted to the major problems encountered. The real-time counselling facilitated the validation of antimicrobial agents. In the wards that most frequently use ASP, a multidisciplinary consultation was set up. Several care pathways were identified and refined (e.g., scars, bone infection and complex post-operative infections).

Analysis of antimicrobial prescription in the different wards led to personalized care pathways which have been embedded in the prescription electronic file and in an algorithm simplifying the pathways. The files have evolved to simplify the questionnaires and to propose preventive strategies.

Several limitations have been noticed. In particular, this observational study can assess neither a comparison of the efficacy with optimal care without ASP nor a cost-effectiveness analysis of an intervention. ASP is time-consuming and variability between IDS exists. Only 45% of all interventions are notified due to lack of manpower. Moreover, the ASP should be extended to private practice and other hospitals in the region.

Finally, this project is part of the region reference site of the European Innovation Partnership on Active and Healthy Ageing MACVIA-LR (38).

Conclusion

Real-time integrated electronic medical records for antibiotic prescriptions and telecounselling by a multidisciplinary team are operating in the Montpellier University Hospital and are in line with the global anti-infection ICT strategy. This management change is fully traceable. The review of the results of the project has led to improvements in patient care through a collaboration between IDS and the other hospital members.

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